

KENYA COLONY AND PROTECTORATE

Department of Agriculture
Annual Report
1937

VOLUME II

1939

PRINTED AND PUBLISHED BY THE GOVERNMENT PRINTER
NAIROBI, KENYA COLONY

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Annual Report of the Department of Agriculture, 1937

VOLUME II

PART V—COFFEE SERVICES

Some introductory remarks will be helpful to a proper visualization of the whole investigational work in progress. Under the heading of Cultural Work is grouped pruning, stumping, planting, spacing, shade, spraying and soil treatment. Under Plant Breeding and Selection comes variety and type trials, the search for and the recording individuality of special types of trees and the individual tree recording of blocks of coffee. Vegetative propagation comes in as a necessary adjunct to selection and breeding work, but is also desirable in connexion with the design of experimental work. The investigations on vegetative propagation include both the rooting and grafting of cuttings.

The country is divided into two main areas for investigational work, the Eastern and Western areas. In the former the main problems may be said to be mealy bug; the regulation of the crop born of individual trees to the maximum size which the trees can bear annually on an average without strain; the finding of trees of a high yielding strain and the substitution of such trees in the most economic way in existing plantations. Shade and manurial treatments for increased yield and moisture conservation treatment are also under investigation. So also is the effect on yield of spraying with Bordeaux mixture, the best methods of applying sprays and the effect of copper generally on the trees. Improvement in liquoring quality is also a most important investigation, together with the eradication of deleterious taints. In the Western area where coffee is usually grown both higher and lower than in the Eastern area, the main problems are, at the higher altitudes, coffee berry disease, bad growth due to what is known as "Hot and Cold", Elgon dieback, sometimes a soil lacking in organic matter, a tainted liquor, and a generally low yield of coffee per acre. At the lower altitudes leaf disease is of considerable importance and there are certain soil difficulties to be overcome as well.

EASTERN AREA

The experimental stations in the Eastern area are the Scott Agricultural Laboratories, the Karimani Experiment Station, Thika, the North Kitito Experiment Station, Makuyu. The work at the latter two stations is based on that at the Scott Laboratories, with modifications in accordance with local conditions. A brief discussion of the work on the chief problems will give a clearer grasp of the detailed reports of the stations.

Mealy Bug.

During the year Mr. Melville, the Entomologist, and Mr. Gethin Jones, the Soil Chemist, carried out an extensive field survey of past and present mealy bug outbreaks in the Limuru, Kiambu, Ruiru, and Thika districts, in order to find out if there is any connexion between the incidence of the pest and any local soil and eco-climatic conditions such as a hollow, a leeward slope, a windbreak, a patch of poor soil, etc. Some thirty-two estates were examined and though at first sight it appeared that outbreaks of mealy bug did tend to occur on the same sites, which had become known as "chronic" spots, this was not confirmed as the survey progressed. It would appear that within a certain climatic range suitable in varying degree for the existence of mealy bug, its actual intensity of natural infestation depends both on the degree of suitability of the climate and on the presence or absence of the attendant ant. At Karimani a number of soil treatments are under investigation to discover their effect on the ant; some of these have been devised by Mr. W. J. Poppleton. Owing to the cost of banding against the ant and to the rather unsatisfactory nature of this method of control, great importance is still attached to a search for parasites of the bug which might lead to biological control—a much more fundamental method. Parasites of the mealy bug species, *Pseudococcus lilacinus*, sent by Dr. Le Pelley from India and the Far East have not proved effective on *P. kenya*e, the local species first described by Dr. Le Pelley, and next year a search is to be made in Uganda and the Congo for this particular species and its specific parasites as there is reason to believe that both exist in those places.

Cultural Work.

Though the single stem system of pruning is in general use over the Eastern area, there is so much to be said in favour of the multiple stem system that comparative yield

tests between the two systems are being continued in the hope that planters may come to regard this system with an un-biassed eye and judge it on its merits. Regulation of crop to the optimum annual amount is so important that, for those to whom the multiple stem system is not attractive, simplified methods of pruning on the single stem system with regulation of the number of primaries is also under investigation. The importance of good planting so that every individual tree in a plantation may be given a chance to yield well has not been overlooked in the investigational work, nor have trials of different spacings of the trees. Trials of shade and of shade trees still retain a premier importance in the Eastern area, an importance in respect of regulation of crop by the searchlight thrown on the meaning of shade by Nutman's work at Amani. Shade trees are being tried all over the Eastern area, both on departmental plots and in co-operation with farmers, as varieties of shade trees seem very localized in value. Spraying both as a means of reducing or postponing leaf-fall (whether from leaf disease, *Hemeleia vastatrix*, or other causes) as a tonic for the leaves in all districts, continues to be the subject of experimentation, in particular the comparative effects of fog spraying with headland pump spraying. Fog spraying is so much cheaper and requires so much less water that if the benefits from spraying are due rather to a tonic effect than a protection, by covering, of the leaves from disease, it should supersede the headland pump method as soon as methods of applying it have been worked out both as to quantities and type of pump. A number of empirical simple manurial experiments have been laid out in co-operation with farmers as a guide to the use and value of manure.

Breeding and Selection Work and Vegetative Propagation.

Owing to coffee growing still being in the pioneering stage, this work is of the utmost importance even in the Eastern area. The "French Mission" variety of Mocha coffee is very mixed in type and some types and even trees are likely to be more suitable and better yielders than others. A real drive has been begun to record the yields of a large number of individual trees on plantations all over the Eastern area. A special staff of native recorders has been engaged for the work. These not only do routine individual tree recording of selected blocks of coffee, but also mark and record trees which show signs of being consistently good yielders. The coffee from as many trees as possible is liquored, by the Liquorer to the Coffee Board, with a view to discovering whether any

actually give a bad liquor, so that such may be eliminated; otherwise no attempt is made to distinguish fine differences in flavour.

Since any trees which may be found over a period of years to be consistently good yielders may be made use of in existing plantations, another important investigation in progress was in connexion with grafting. Trials of different methods of grafting and at different times of the year were undertaken and the preliminary results are distinctly promising. Trials of compatibility between various scions and root-stocks were also in progress. The variability consequent on grafting, long range work, investigating the possibilities of rooting cuttings is also in progress. It should be understood that all trees whose recorded yield in the field seems promising will have to be tested out by means of grafts or seedling material as uniformly as possible, growing on uniform soil or similarly on rooted cuttings, before they can be recommended for use as hereditarily better material.

With a view to the future, comparisons are also being made of the economics of interplanting existing plantations with superior seedling material or of top-working.

Variety trials, all laid out in a similar plan, have been started on all these stations in the Eastern area. The varieties are grown both on the single stem and multiple stem systems, and are shaded and unshaded. Selected types will eventually become varieties and go into the variety trials.

WESTERN AREA

The experiment stations in the Western area are at Kepchomo Estate, Nandi, with a sub-station at Sotik, at Kitale, and on Kapretwa Estate, Mt. Elgon.

Coffee Berry Disease.

This can probably be said to be the primary consideration of Nandi and Sotik. The variety trials at Sotik flowered well and a native recorder has been stationed there to record the individual tree yields of the more important varieties which will then be giving their first crop. These records will give most valuable information on the resistance to disease of various varieties and show whether any of them are worth growing in areas subject to coffee berry disease. Native recorders are also stationed in Nandi district and both there and on Kepchomo Estate are searching for and recording trees

which show signs of resistance to this disease. The variability in the French Mission variety provides a fertile field for this sort of work. At Kepchomo Estate further trials with sprays and spraying against the disease are also in progress. Meteorological records are being taken both inside and outside plantations which commonly do or do not suffer from coffee berry disease to see to what extent climate, as represented by temperature and humidity, is responsible for its incidence. On the station at Mt. Elgon, where coffee berry disease is also to some extent in evidence, investigations are being made into the effect of nutrition on the incidence of the disease.

"Hot and Cold."

This description of a physiological manifestation or habit of growth common to coffee growing at all the higher elevations is possibly a misnomer. It is, however, the subject of special study at the Kitale Experiment Station and some specialized work on it, with nutrition as the basis, has been done on it at the Mt. Elgon station. Trials of the effect of shade on different varieties and types of coffee are in progress at the Kitale Station, and consequently a number of different shade trees are themselves the subject of trials. Shade has certainly been shown to mitigate the incidence of "hot and cold" and some varieties of coffee are definitely less prone to this habit of growth than others.

Elgon Dieback.

This continues to be the special subject of investigation at the Mt. Elgon Station. Certain varieties and types have been proved to be more resistant to it than others, and a large number of individual tree yields are being recorded and the suitability of their liquoring quality tested. The value of shade on all varieties has been confirmed, and shade and shade trees are naturally undergoing trial. The officer in charge of the station is making a special study of the causes of Elgon dieback and what he believes to be its hand-maiden—"hot and cold". Meteorological records are also being taken.

Leaf Disease.

This is very prevalent and damaging in the lower parts of the Western area, such as Muhoroni and Lower Songhor, and spraying trials are being continued. Great hopes are, however, being centred on two apparently highly resistant trees on an estate at Muhoroni. Their yields have been

recorded for two years, and they have now been prepared for the production of sucker growth for grafts and rooted cuttings.

Cultural Work.

Coffee grown on the multiple stem system is more common in the Western area than in the Eastern area, but the two systems are being compared. Much attention is being given to instructing planters in the proper carrying out of the multiple stem pruning system and to the advocacy of the concomitant use of shade. Regulation of crop on individual trees is also being studied, and at Nandi in particular various methods are being tried of inducing flowering, as in the climatic conditions there obtaining the trees tend to vegetative growth rather than fruiting. The land has been prepared for spacing trials at Nandi and Kitale. Empirical manurial and mulching trials, cover cropping and green manuring experiments are in progress on a number of estates. Soil improvement and management are most important features of the work in parts of the Western area.

Plant Breeding, Selection and Vegetative Propagation Work.

This has been started on similar lines to that in the Eastern area, and is directed not so much with a general objective of higher yield in view but specifically to overcome the various diseases and adverse physiological manifestations found in the Western area.

SOLAI-SABUKIA

This area lies between the Eastern and Western areas, but is not large enough to warrant an officer being stationed there. Work specially applicable to it, such as shade and shade tree trials, recording of individual tree yields, vegetative propagation studies and manurial trials, are, however, done in co-operation with planters and under the supervision of periodical visits of an officer from the Eastern area.

GENERAL

Soil Nutrients

The chemical work of the coffee team has been directed towards an investigation of the phosphate and potash status of the lava-derived red soils of the Eastern area. Whilst liberal applications of phosphates have to be made so that sufficient will become available annually, it has been found that these soils are well supplied with potash in freely available form.

Water Pollution.

An investigation in collaboration with the Public Works Department was begun in an attempt to tackle the problems of pollution of streams with coffee factory effluents, with a view to removing the possibility of tainting the coffee. The investigation should be completed in 1938.

Effect of Micro-Flora on Liquoring Quality.

Reports have been received from Brazil to the effect that beneficial results on liquoring quality were obtained by spraying coffee trees (whilst the cherries were still immature on the trees), in districts which usually produced a harsh Rio flavour, with yeasts obtained from fermented coffee grown in districts growing a mild flavour. Various experiments in connexion with this were made during the year, but the liquoring results showed that no results were obtained.

Meteorological Records.

Arrangements were made to begin taking meteorological records in practically all districts under the various local conditions in which coffee is grown, in order to increase the knowledge of what these conditions are, how they differ from place to place, and what the effect is. The records taken are usually temperature and humidity, supplemented in some places by sunshine and wind records. The assistance of the Meteorological Department is gratefully acknowledged. These records are likely to be of particular value in connexion with the main problems in the Western area.

Liquoring Quality.

An investigation was begun into the value of liquoring reports as a means of assessing correctly the quality of coffee, both in regard to its commercial value and as a means of differentiating between the effects of different cultural or factory treatments on the quality of the bean. Results are not likely to be obtained until 1938 or 1939.

ACKNOWLEDGMENTS

The new organization of the coffee services was begun on January 1st, 1937, and it is very pleasant to record how extremely well all members of the coffee team have worked and pulled together during the year and to acknowledge the co-operation of members of the Department outside the team. This, the first and most difficult year of a new regime, is a happy augury for the future. The loyal co-operation and

support that I, as leader, have received in a quite new sphere of work has been an inspiration and is most gratefully acknowledged. It is to this that the recognized success of the team has been mostly due, but also of the greatest assistance has been the invigorating and helpful support accorded by all sections of the coffee industry, the planters, the Coffee Board, the Trade, and those individuals and concerns who have placed their estates and so much of their time and energy at the team's disposal either for experiment stations or for co-operative experiments. These co-operative experiments are of unestimable value. Lastly, a tribute is due to the Coffee Board's liquorer for the way in which he has placed his expert knowledge so freely at our disposal and for the immense amount of time and enthusiasm he has devoted to the most important part of our work. Without his help much of our work would be impossible to do satisfactorily, and especially in connexion with the liquoring investigation he has had to do his part mostly in the dark as to results.

G. J. L. BURTON,

Senior Plant Breeder and Experimentalist

THE SCOTT AGRICULTURAL LABORATORIES

INVESTIGATIONAL WORK ON COFFEE

Rainfall

The rainfall recorded at the Scott Agricultural Laboratories for the year was 58.80 inches. This was 18.12 inches in excess of the previous year's total, and 19.66 inches above the average for the past twelve years. Excessively heavy rains fell from March to June and again from October to December, but the marked long dry spell during July, August and September adversely affected the coffee crop.

MONTHLY RAINFALL—SCOTT LABORATORIES

MONTH					Inches	Average Monthly Rainfall Over 12 Years
January	..	..	..	..	0.23	1.92
February	..	..	..	..	Nil	1.06
March	..	..	..	..	4.97	5.06
April	..	..	..	..	14.95	8.60
May	..	..	..	..	12.42	7.14
June	..	..	..	..	7.78	1.75
July	..	..	..	..	0.28	0.64
August	..	..	..	..	0.18	1.03
September	..	..	..	..	Nil	1.21
October	..	..	..	..	5.88	2.72
November	..	..	..	..	8.99	5.18
December	..	..	..	..	3.12	2.83
					58.80	39.14

*Variety Trials**Material Collected Locally or Introduced from Outside the Colony*

Planting material of the following coffees was obtained during the year and planted out in the nurseries:—

ORIGIN					Name	Material	Planted
Lindi	..	..	..	..	<i>C. zanguebarensis</i>	Seed	13-1-37
Amani	..	..	..	..	<i>C. excelsa</i>	Seed	8-6-37
Amani	..	..	..	..	<i>C. Dybouski</i>	Seed	1-9-37
Lake George, Uganda ..	..	..	..	..	<i>Coffea</i> sp.	Seed	—
Ivory Coast	..	..	..	..	<i>Coffea indenie</i>	Seed	1-1-38
Amani	..	..	..	..	<i>Robusta</i> 140-01	Seed	19-1-38
Embu Forest	..	..	..	..	<i>Coffea</i> sp.	Seed	—
Lake Paradise, Marsabet	..	..	..	..	<i>Coffea</i> sp.	Seedlings	1-8-37

Fifteen different varieties are under observation at the Scott Laboratories. All varieties are now being grown on the multiple and single stem pruning system; a portion of each system will ultimately be shaded by tree shade and a portion remain unshaded. This step has been taken as it has been observed that there is a marked difference in the behaviour of different varieties when grown on the different pruning systems.

Plots of different varieties are also being established on estates as co-operative experiments. This step is necessary as the range of altitude and climatic conditions throughout the district is so great that no central trial could possibly give results comparable to the whole area.

Selection Work and Individual Tree Recording

Considerable progress has been made with selection work during the year. In addition to approximately thirty individual trees selected on the Laboratories and on estates that have been recorded, a commencement has been made in recording blocks of one hundred trees or more on estates with the twofold object of finding consistent high-yielding trees for multiplication and to discover the degree of variability that exists in seedling plantations on Kenya estates. In all, over one thousand trees have been recorded in different areas east of the Rift Valley. The results of the first year's work are most encouraging and suggest great possibilities for the future.

At the Scott Agricultural Laboratories outstanding trees selected from various districts are being propagated by grafting, in order to test them as possible sources of material for top working on a commercial scale. At the same time multiplication of material from these trees, by means of grafting, is proceeding as rapidly as possible, so that large areas of coffee may be top-worked with the minimum of delay when the value of the trees has been proved.

Shade Experiments

During the year under review it has been possible to commence a systematic study of possible shade trees for use in coffee. A coffee shade tree arboretum has been laid down at the Scott Agricultural Laboratories and already forty-seven different varieties of shade trees have been planted out over coffee for observation. The object of the arboretum is to allow some indication to be made of the possible merits of a wide range of trees. When any one tree shows desirable characteristics it is to be planted out in blocks over established

coffee in the different districts, with the co-operation of coffee planters. During the year a number of these co-operative trials were commenced, plots having been laid down in Upper Kiambu, Kiambu, Lower Kiambu, Kabete, Machakos, Nyeri, and Solai. It is hoped to increase the number of plots during the forthcoming year.

A shade tree nursery has been established at the Scott Agricultural Laboratories, and it is hoped that shortly a large supply of seedlings will be available for the co-operative trials on estates. Our thanks are due to the Conservator of Forests, Nairobi, and his staff, especially Mr. Galt of the Karura Forest Station, for much advice and for the supply of plants and seed.

Pruning Experiments

Experiment I—Monthly Pruning

This experiment, in which the effect of pruning at twelve different times of the year was under investigation, was commenced in 1933 and has now been concluded. It can be claimed that the main object of the experiment, i.e. to determine to what extent the amount and time of flowering are correlated to the time of pruning, has given satisfactory observational results. It has been shown that under normal climatic conditions now wood will not produce a flowering at the Scott Agricultural Laboratories until it is at least ten months of age. Thus pruning in February-April will ensure a February-March flowering the following year; whereas an out-of-season pruning, say August-September, will be too late for the new wood formed to flower in the following March and a large October-November flowering will result. Therefore, pruning does influence the amount and time of flowering, and it is obviously a factor that planters in all districts should take into consideration. Whilst ten months is the minimum age for new wood to flower at the Scott Agricultural Laboratories, this period will be found to vary considerably at the different altitudes.

After crop recording the plots for two years it became apparent that the results were likely to conflict with the general principles of pruning, and for this reason the experiment has now been controlled.

Experiment II—Multiple Stem Pruning

The plot established on the multiple stem system at the Scott Agricultural Laboratories has yielded 7.4 cwt. of clean coffee per acre during 1937. This amount was considerably

above our estimate. Planters who are interested in this pruning system should note that the pruning cycle on this plot is now in the change-over stage and are advised to visit the Scott Agricultural Laboratories to see the method of pruning adopted. The average yield over a nine-year period now amounts to 8.04 cwt. per acre per annum.

Experiment III—The Establishment of a Multiple of Stems by Different Methods

The first year's crop weights were recorded from this experiment during 1937. The following weights were obtained:—

		Cherry Coffee
		Lb.
PLOT I	.. Guatemala system	243
" II	.. Guatemala system, but select verticals along stem	225
" III	... Single stem for two seasons, then convert	146
" IV	.. Costa Rica system—capping system ..	117
" V	.. Costa Rica—new system	84
" VI	.. Capping system—ordinary	292
" VII	.. Capping system—removal of best head	319

No significance must be attached to the crop weights. It is only after a number of years recording that the difference in crop weights between plots can be judged. This experiment was laid down with the object of determining which method of establishing the multiple of heads was most suited to conditions similar to those at this station. Special attention is being paid to the control of mealy bug and to the economics of the pruning methods on the different systems.

Experiment IV—A Comparison of the Multiple Stem System of Pruning vs. the Single Stem System

An experiment designed to compare the multiple and single stem systems with reference to yield, quality, out-turn, resistance to drought and incidence of pests and diseases was laid down at the Station during the year. The experiment was planted up with the Bourbon variety of coffee in April and the multiple stem plots were bent over on the agobiada system in December.

In the lay-out of the experiment, each treatment has been replicated twelve times. Each plot consists of twenty trees surrounded by a border row. The border row was considered necessary in this case due to the possibility of the shade from

the multiple stem trees influencing the single stem trees. The lay-out is as follows:—

B	A	A	B
A	B	B	A
B	A	A	B
A	B	B	A
B	A	A	B
B	A	B	A

A—Single stem. B—Multiple stem.

Experiment V—Multiple Stem vs. Different Methods of Single Stem Pruning

(i) *Object.*—The object of the experiment is to determine whether it is possible to modify the old and recognized method of single stem pruning to a method which simplifies the whole operation of pruning, thereby bringing the pruning costs to a level comparable with those of the multiple stem system.

(ii) *Lay-out.*—Two new methods of single stem pruning are being tested out against the old method and also against the multiple stem method. Each of the four treatments is replicated six times in randomized blocks, and the whole is superimposed on a manurial experiment embracing full mulch, alternate row mulching and box ridging. The lay-out is as shown below:—

A	× × × × × × × × × × × C × × ×	0000000000000000 000000 A 000000
D	× × × × × × × × × × × B × × ×	0000000000000000 000000 C 000000
B	× × × × × × × × × × × D × × ×	0000000000000000 000000 B 000000
C	× × × × × × × × × × × A × × ×	0000000000000000 000000 D 000000
× × × × × × × × × × × O × × ×	0000000000000000 000000 D 000000	C
× × × × × × × × × × × A × × ×	0000000000000000 000000 C 000000	B
× × × × × × × × × × × B × × ×	0000000000000000 000000 A 000000	A
× × × × × × × × × × × D × × ×	0000000000000000 000000 B 000000	D

Complete Mulch
Alternate Row Mulch
Box Ridging

A. Ordinary Single Stem Pruning C. Modified Pruning. System II
B. Modified Pruning. System I D. Multiple Stem Pruning

Modified Pruning under System I consists of a limited number of primaries capped approximately 10 in. from stem. Secondaries are then developed and are in turn cut at approximately 10 in. from primary, thus developing a strong fan-shaped growth from each primary.

Modified Pruning under System II consists of a modified single stem system with a reduced number of primaries and very open growth.

The experiment was planted up with S.L. 4 type (a green tip, Bourbon type) of coffee in April, 1936. The initial pruning was carried out in July, 1937.

Experiment VI—Spacing Trials

A number of different spacings are under observation at the Laboratories. The plots were planted in 1932, and crop weights from each treatment were recorded during 1937. The following are the different treatments:—

Spacing 9 ft. × 9 ft. (Square)		Capped at 5 ft.	
„	9 ft. × 9 ft.	„	4 ft. 6 ins.
„	9 ft. × 9 ft.	„	4 ft.
„	8 ft. × 8 ft.	„	5 ft.
„	8 ft. × 8 ft.	„	4 ft. 6 ins.
„	8 ft. × 8 ft.	„	4 ft.
„	7 ft. × 7 ft.	„	5 ft.
„	7 ft. × 7 ft.	„	4 ft. 6 ins.
„	7 ft. × 7 ft.	„	4 ft.
„	8 ft. × 8 ft. (Triangle)	„	5 ft.
„	8 ft. × 8 ft.	„	4 ft. 6 ins.
„	8 ft. × 8 ft.	„	4 ft.
„	7 ft. × 7 ft.	„	5 ft.
„	7 ft. × 7 ft.	„	4 ft. 6 ins.
„	7 ft. × 7 ft.	„	4 ft.

Each different spacing consists of one plot only in which a sub-plot of nine trees is being recorded.

(c) *Re-filling Gaps in Established Coffee.*—This experiment was also commenced during 1937. A number of different methods of planting were used in order to discover which was the simplest and best method of re-filling gaps. A plot of established Blue Mountain coffee was used for the experiment. A number of the existing trees were removed and re-fills planted. The following is the lay-out of the experiment as Plan C:—

PLAN C
REFILLING GAPS

×	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×
×	C	×	Q	×	X	×	L	×	H	×	X	×	L	×	V	×	S	×	C	×
×	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×
×	A	×	W	×	K	×	M	×	V	×	I	×	J	×	N	×	U	×	H	×
×	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×
×	B	×	S	×	I	×	D	×	J	×	W	×	O	×	F	×	K	×	G	×
×	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×
×	O	×	G	×	U	×	F	×	R	×	A	×	R	×	D	×	Q	×	P	×
×	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×
×	N	×	E	×	T	×	P	×	×	×	T	×	M	×	B	×	E	×	×	×
×	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×
×	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×

Bare Planting—

Without manure—Holes	6 ins. × 1 ft.	..	..	A
With manure — „	6 ins. × 1 ft.	..	..	B
Without manure— „	2 ft. cube	..	..	C
With manure — „	2 ft. cube	..	..	D

Ball of Earth—

Without manure— „	6 ins. × 1 ft.	..	..	E
With manure — „	6 ins. × 1 ft.	..	..	F
Without manure— „	2 ft. cube	..	..	G
With manure — „	2 ft. cube	..	..	H

Basket Planting—

Without manure— „	6 ins. × 1 ft.	..	..	I
With manure — „	6 ins. × 1 ft.	..	..	J
Without manure— „	2 ft. cube	..	..	K
With manure — „	2 ft. cube	..	..	L

Stumped Old Trees—

Without manure— „	no preparation	..	..	M
With manure — „	no preparation	..	..	N
Without manure— „	large holes	..	..	O
With manure — „	large holes	..	..	P

Spraying Experiments

Bordeaux Spraying: Headland Pumps.

The experiment laid down in 1934 has been continued. The results are once again of great interest. It will be remembered that all plots carried very heavy crops in 1936. As a result of the over-cropping, one tree in the control plot died and several others have a severe setback. All trees in the sprayed plots made a rapid recovery after the removal of the 1936 crop, and although only small crops were harvested in 1937, good yields are anticipated in 1938. The table below shows the crop weights harvested from each plot over a period of four years; it will be noted that with the exception of one treatment— $\frac{1}{2}$ per cent Bordeaux Mixture applied in March only—all sprayed plots have given a 100 per cent increase yield over the control:—

	CROP WEIGHTS IN CWT. CLEAN COFFEE PER ACRE				
	1934-5	1935-6	1936-7	1937-8	Average 4 Years
1 per cent Carbide—					
March	5.78	6.30	20.90	4.10	9.27
March-June ..	5.70	5.99	23.40	4.00	9.77
$\frac{1}{2}$ per cent Carbide—					
March	6.50✓	6.13	14.20	2.00	7.21
March-June ..	6.46	10.61	16.60	6.30	9.99
Control	3.60✓	2.05	10.00	0.78	4.11
Burgundy Mixture ..	8.40	4.70	21.00	2.10	9.05
AVERAGE PLOT YIELD	6.06	5.96	17.68	3.21	8.23

Fog Spraying

During the year important developments have taken place regarding the method of application of Bordeaux Mixture. Experimentation has shown that excellent results, comparable with ordinary headland pump spraying, can be obtained by applying a smaller quantity of the spray in a more concentrated form with a fog or mist sprayer. Our recommendation for fog spraying, at the conclusion of the first year's work, is to apply a 4 per cent solution of Bordeaux Mixture at the rate of approximately two-fifths of a pint per tree; two applications to be made per year. This form of spraying is obviously far more economical as regards labour

and water requirements than ordinary spraying and greatly speeds up the rate at which spraying can be done. Full details of the work conducted and conclusions reached have been reported in the Press, so that repetition here is not necessary.

Germination Experiment

An experiment has been commenced to determine whether the rapidity of germination of the coffee seed bears any correlation to the cropping capacity of the ultimate plant. The seedlings are still in the nurseries, but will be planted out during 1938.

Soil Erosion

Great care has been taken throughout the year to reduce erosion to an absolute minimum. The whole area is now carefully contoured with ridges or box-ridged. A number of plants to established on the contour ridges are being demonstrated. These include:—

- (a) *Tephrosia vogelii*
- (b) *Lathyrus* sp. (Everlasting Pea)
- (c) *Erigeron mucronatus* (Mexican Daisy)
- (d) *Alternanthera* sp. (Babu's Delight)
- (e) *Glycine javanica*

Tephrosia vogelii has been found to be excellent for this purpose, especially in young coffee, where it also acts as a splendid windbreak.

Lathyrus sp. (Everlasting Pea) can also be very strongly recommended, but must be kept under control.

Stumping

Several important points connected with stumping coffee were observed during the year. It has been shown that the utmost care must be observed in the operation of stumping and in the protection of cut surfaces. An improved technique has been described in an article by Mr. T. H. Jackson which appeared in the Press.

Factory Work

The Assistant Agricultural Officer, Mr. Pratt, has had a particularly busy season in the factory, where he has had to handle many hundreds of different samples. In addition to the routine samples necessitated by the field experimental work, numerous fermenting experiments were carried out in

co-operation with the Biochemist to determine what effect foul fermentation has on liquoring qualities. Also in co-operation with the Soil Chemist (Mr. Gethin Jones) a large number of experiments has been carried out in inoculating fermenting coffees with various yeasts in order to discover whether known poor quality coffees can be improved by being treated with yeasts from good quality coffees.

Micro-climatological Study of the Coffee Bush

Careful records on the relation of climate to the growth and behaviour of the coffee bush have been kept throughout the year. A mass of data has been collected, and it is hoped to publish a summary of the results to date in due course.

Soil Treatments

(a) As mentioned under Section (II) Experiment V (see plan), an experiment has been laid down to test the comparative effects of complete mulching, alternate row mulching and box ridging.

(b) The demonstration of the comparative effect of applying organic manures broadcast, in holes and in furrows between the rows and of mulching to note effect of their treatments on root and aerial growth has been continued. No root growth observations have yet been made as it is considered that the different methods of application of the manure have not yet had their maximum effect. Aerial growth observations show healthier and more vigorous growth on the mulch plot as compared to other treatments.

Vegetative Propagation

The following report compiled by Mr. T. H. Jackson, Officer in charge Vegetative Propagation, gives a full account of the work conducted by him at the Scott Agricultural Laboratories and in the district:—

(1) *Cuttings*.—Good progress was made throughout the year in the technique of rooting cuttings. Clonal cuttings only were used in all the work undertaken.

An improved propagator, designed to reduce the daily variation in temperature, was built early in the year and has proved very satisfactory in use.

A number of experiments have been carried out on the reaction of *C. arabica* cuttings to growth substances, and outstanding results have been obtained. The two growth

substances tested were "Hortomone A", an Imperial Chemical Industries product, and "B-indolylacetic acid." Following on good results from preliminary tests, an experiment was laid down which definitely proved that the growth substances used had an accelerating and stimulating effect on root growth. An account of the experiment appeared in the November issue of the *East African Agricultural Journal*.

Young green sucker wood for cuttings has proved far superior to older wood in rooting capacity, and it has the added advantage of being rapidly produced by the parent tree. As a result of the improvement in technique, a start has been made with the work of raising clonal populations from cuttings for use in laying down experiments and for the testing of individual trees.

Acknowledgment is due to Mr. V. A. Beckley for much help with the work on growth substances.

Cuttings planted out in the field in 1932 have just borne their third crop of approximately 7 cwt. per acre; the trees produced a good bold bean and showed no signs of strain at the end of the picking season. Coffee picked from clonal cuttings was again outstanding for evenness of size and shape of bean.

(2) *Grafting*.—Much work has been done during the year on the technique of top working mature coffee trees. A large co-operative experiment, for the study of this problem, was laid down on twelve estates situated in Upper and Lower Kiambu, Ruiru, Thika, Makuyu, Mitubiri, Donyo Sabuk and at the Scott Agricultural Laboratories. The objects of this experiment are as follows:—

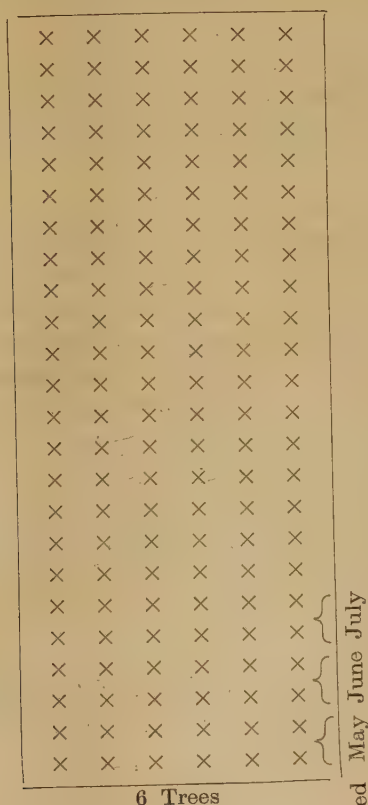
- (a) To ascertain whether grafting is a practical method for the regeneration of existing coffee plantations;
- (b) To determine to what extent climatic conditions influence the success of grafting.

The appended plan shows the lay-out of a grafting plot; the experiment consists of twelve such plots and one at the Scott Laboratories which contains twice the number of trees. The original plan was to graft two rows of six trees each, every four weeks for a period of twelve months; one row to have scions grafted directly on to the stumps of the original trees and the other row to have scions grafted on to suckers produced from the stumps of the original trees. Grafting

commenced in May, and in July the method of grafting direct on to the stump was abandoned as impracticable. The experiment will not be concluded until November, 1938, but the results obtained during 1937 are very encouraging and leave little doubt that the top-working of coffee is a practical proposition in the majority of the districts covered by the experiment.

PLAN OF GRAFTING PLOT IN THE CO-OPERATIVE GRAFTING EXPERIMENT

24 Rows



Grafted May June July

During the year a number of native employees from several estates have been trained in the technique of grafting.

(3) *Rootstock Experiment*.—The dwarfing effect of the *C. eugenioides* rootstock is so marked that a certain degree of incompatibility is suspected, which may show itself at a later date in the early death of the trees.

C. robusta, owing to its shallow root system would seem to be unsuitable as a rootstock, except possibly in areas of high rainfall. At the Scott Agricultural Laboratories the trees on this rootstock are susceptible to drought, and do not ripen their crop well; however, in areas where vegetative growth is excessive, and difficulty is experienced in throwing the trees into flowering, such a rootstock might have good results.

The remainder of the rootstocks in this experiment are, so far, exerting no visible influence over the scions grafted on to them.

(4) *General*.—A method has been evolved for producing large quantities of vertical wood from selected trees, which will be of great value in working up clones by means of cuttings and grafts.

The method was first tried out on a few stumped trees which had subsequently produced a number of verticals. The technique was as follows: All primaries were removed from the verticals, except for a small tuft at the top of each, which was left to draw up the sap; each vertical was then bent over and pegged down; in a very short time suckers were produced at almost every node, and in about three months from the time of bending over it was possible to use them for cuttings.

The number of suckers produced will naturally vary with the number and length of the verticals. The trees on which the test was carried out had from eight to ten verticals, which were about 5 feet in length; each tree was capable of producing about 500 suckers in a year.

S. GILLETT,
Agricultural Officer and Experimentalist

KARIMANI FIELD STATION

RAINFALL

Rainfall was recorded from the 15th May and the following results obtained:—

15th-31st May	2.31	inches	rain	fell	on	3	days
June	5.53	"	"	"	"	14	"
July	Nil						
August	0.51	"	"	"	"	5	"
September ..	1.05	"	"	"	"	1	"
October	5.54	"	"	"	"	13	"
November ..	12.76	"	"	"	"	13	"
December ..	4.36	"	"	"	"	9	"

TOTAL ..	32.06	inches	for	seven	months
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The above rainfall shows a vast improvement over the immediate preceding years for the district.

PRUNING EXPERIMENTS

Owing to various circumstances the station could not be opened until the pruning season, and the bushes in the established coffee have in the past been subjected to an entirely unsystematic method of pruning which necessitated severe regulation of wood in order to establish more uniform trees as a basis for future experimental work. These two factors precluded any specific pruning experiments being commenced during the period under review. Seven months is not a sufficiently long period to accomplish the uniformity desired, but it is hoped that further wood regulation in the early months of 1938 will give such results that pruning experiments can be begun.

These will include multiple stem versus single stem with and without regulated primaries. The object of the experiment being to determine as far as possible the merits of the systems and in regard to regulated primaries to ascertain if by judicious regulation an economic crop can be borne annually without detriment to the trees.

SHADE EXPERIMENTS

The shade experiments are of two types, firstly an arboretum of a number of different trees is being established to determine the nature, growth and suitability of each tree as a shade under the climatic conditions prevailing, secondly, blocks of shade trees of certain selected varieties are being planted to determine the effect of each variety of trees on the coffee bushes under them.

In regard to the block planting, five species were planted with twelve trees in each block. The arboretum consists of approximately thirty different species or varieties. Further land has been allotted for the continuation of this experiment, which will be planted as and when further trees are available.

SPRAYING EXPERIMENTS

No spraying experiments were conducted at the station during the year.

SOIL TREATMENTS AND MANURIAL EXPERIMENTS

A considerable number of soil treatments and manurial experiments were carried out. Treatments included full mulching, alternate row mulching, box-ridging, and the application of organic and inorganic manures.

The trials were designed for the dual purpose of observing the effect on the coffee bushes but more particularly the effect of certain of the treatments on the quality of the coffee bean.

TREE SELECTION AND RECORDING

Two native recorders have commenced recording the yield of individual trees in the district; one is working on a block of a variety known as Jacksons and the other on a block of ordinary French Mission. Samples from many of these trees have been forwarded for liquoring tests together with data in regard to yields of each individual tree in the blocks.

Unfortunately owing to the severe regulation of wood which had to be done late in the season at this station, there was insufficient crop to justify tree recording, but both a particular block and some individual trees of apparently outstanding merit have been marked down for this purpose later on.

VARIETY AND TYPE TRIALS

Preparation of land for the planting of variety trials was commenced during the year. Holing has already been completed and planting will take place in the March-April rains season of 1938. The experiment is designed to study the behaviour of the various types and varieties with and without shade, under the multiple and single stem systems of pruning.

Some established coffee has been stripped almost completely of primaries in order to induce sucker growth on which eventually grafting will be carried out with scion material of selected varieties and types. This will provide a variety trial of grafted types.

MEALY BUG (*Pseudococcus kenyae*, LE PELLEY)

Field experiments have been started which are directed towards the control of the attendant ant *Pheidole punctulata*, and consist of a variety of soil treatments. Comprehensive trials are also in progress with proprietary banding greases. A few types of banding greases were obtained from various commercial firms, each type being applied to eight trees. Each band was of an approximate uniform depth and width and grasses were applied direct to the bark, with the exception of two trees in each row which had a preliminary treatment of Melanoid bituminous paint.

The various commercial firms concerned have had detailed reports on their products which it is hoped will result in an improvement in some of the banding greases or their withdrawal from the market. The results of the trials are being published in the Coffee Board Bulletin.

BENITA (KASARINI) FIELD STATION

Work was continued on the bionomics of *Antestia*, and Dr. R. H. Le Pelley resumed charge on his return to Kenya in September.

This work was a continuation of the study of *Antestia* bionomics which had been planned early in 1934 as one of the major projects recommended to be recognized as such by the Amani Conference on co-ordination of Agricultural Research and Plant Protection, February, 1934, and which has been continued uninterrupted up to the present. Considerable further information on the bionomics of the insect under field conditions was obtained during the year along the same lines as have been published in previous annual reports.

Because meteorological observations were being recorded continuously at this station in connexion with the study of *Antestia* bionomics, it was decided at the end of 1934, with the advice and collaboration of the Director of the B.E.A. Meteorological Service, to attempt to determine the relations between the growth of the coffee plant and various climatic factors.

The meteorological observations recorded include temperature and humidity of the atmosphere, sunshine, wind velocity and direction, soil temperatures and rainfall.

Two areas were chosen for this work, the first (A) consisting of 100 young coffee trees, one year old from planting, and the second (B) of 96 trees of mature coffee. Rain gauges

were placed in the neighbourhood of each plot and the following measurements and weight of cherry picked per tree have been recorded since the work began in December, 1934:—

Plot (A). Measurements made monthly—

- (i) Girth of tree.
- (ii) Height of tree.
- (iii) Length of a chosen primary, and
- (iv) Distance between pairs of primaries.

In addition, the crop picked on each tree has now begun to be weighed and recorded.

Plot (B).—When the work was begun the girth and height of the tree were measured and the number of primaries noted. The weight of cherry picked per tree has been recorded since 1935, and dry weight records have been begun for the 1937–38 crop.

It is hoped that it will be possible to begin an analysis of the figures obtained after a period of five years, although over such a short period of time no more than indicative results are likely to be obtained. Records will have to be continued over a considerable number of years if conclusive evidence of the effect of seasonal variation on the coffee plant is to be obtained.

It is possible that the results of this work combined with the meteorological observations going on in other parts of the country, will provide useful information on the stability of different districts for coffee growing.

KEPCHOMO EXPERIMENT STATION, NANDI AND DISTRICT

INVESTIGATIONAL WORK

The district covered by the Officer in Charge of the Kepchomo Station included Kipkarren, Nandi, Songhor, Koru, Fort Ternan and Sotik. All the investigations on the Kepchomo Station itself, dependent on crop for the tabulated results, were rendered abortive owing to an almost complete absence of crop from the coffee. This was due to adverse climatic conditions, mostly at the flowering period. These experiments consisted of:—

(1) Tests of the effect, compared with Bordeaux mixture, of a number of new copper sprays on the incidence of coffee berry disease.

(2) Tests of spraying with Bordeaux mixture in March, May, April and June respectively on the incidence of coffee berry disease compared with no spraying. This was done on coffee spaced both at 7 ft. x 7 ft. and 9 ft. x 9 ft. The sprayings were observed to have a tonic effect on the vegetative growth of the coffee.

(3) A test of the incidence of coffee berry disease on well pruned and well cared for coffee compared with that on neglected and overgrown coffee; in other words, a comparison of the effect of open growth with that of shut-in growth on coffee berry disease.

(4) An observational manurial experiment for the purpose of comparing the effect of *boma* manure and green manures with no treatment; also a trial of the effect of potash and phosphates on coffee quality.

The above experiments will be repeated in 1938.

Other experiments, not involving immediate crop return, were put in hand during the year. These were:—

(1) A plantation conversion experiment designed to find the most economic way of converting existing plantations over to a new variety of coffee. In-arching, grafting and different ways of inter-planting are being compared with plain uprooting and re-planting. A more detailed report on this experiment will be published when it has progressed further.

(2) For those planters who are contemplating the conversion of single stem trees to the multiple stem system, a test of the following four methods of conversion has been started on an acre of land:—

(a) Complete stumping.

(b) Cutting up, leaving a canopy.

(c) Capping at three feet and allowing suckers to develop on the top of the bush and carry crop until suckers at base have developed.

(d) Cutting away one side of the bush and allowing suckers to develop on that one side from the base.

Treatment (a), complete stumping, produced weak, spindly suckers; in treatment (d) the suckers were slightly drawn up by the remaining half of the bush; but treatments (b) and (c) produced good strong suckers.

(3) In order to test the single versus the multiple stem systems of growing coffee, an acre of coffee was divided into a number of replications of each system.

(4) *Green Manure and Cover Crop Trials.*—Several varieties of peas, beans, vetches and lupins were sown during the year, but these all failed during the long rains. It will be hard to find green manures and cover crops that will thrive under the heavy overhead shade necessary for coffee growing in Nandi.

(5) *Shade Tree Arboretum.*—During the year an arboretum of a number of varieties of shade trees was started. Both seedlings and cuttings were planted and these included many kinds of local trees. Growth is comparatively slow at 7,000 feet, and it will take several years before any of the permanent trees give any shade.

Shade is essential for successful coffee growing in the area under review and vigorous efforts have been made in the last year to induce settlers to concentrate on shade planting. Seeds and plants have been issued when available, but there is no lack of planting material, as every district has a number of proved suitable indigenous shade trees which are preferable to experimental introductions for large-scale plantings.

(6) *Tree Selections and Recording.*—A number of coffee bushes have been recorded on plantations in the district. Two bushes of special interest are those numbered K.6 and K.7 on Mr. R. H. Walker's farm at Muhoroni. These appear to be highly resistant to leaf disease. They have been recorded and kept under observation by Mr. Walker for the past two years and have given very satisfactory yields. They will be kept under observation, and sucker growth is being induced in order to make a start with their propagation vegetatively.

(7) Other coffee bushes under observation include a number apparently showing resistance to coffee berry disease at Songhor and in Nandi. At the Kepchomo Station observations have been made on outstanding bushes with a view to finding desirable types resistant to coffee berry disease. These parent bushes, if proved, will provide grafting material for the conversion of the present susceptible plantations.

CO-OPERATIVE EXPERIMENTS

(8) Co-operative experiments were started in the Turbo-Kipkarren area in 1937. The assistance given by the settlers concerned was excellent and with the experience gained in the first year the experiments should go ahead and provide some useful information for planters in the district.

The experiments being conducted are as follows:—

- (a) The use of Grevillea shade, regulated and unregulated.
- (b) Single stem system versus multiple stem.
- (c) Methods of converting single to multiple stem.
- (d) Observational manurial experiment: three treatments with and without bone meal:—
 - (i) Compost or boma manure;
 - (ii) Compost or boma manure plus bone meal;
 - (iii) Mulching alternate rows;
 - (iv) Mulching alternate rows plus bone meal.
 - (v) Controlled weed growth;
 - (vi) Controlled weed growth plus bone meal.

Small potash experiments were laid down in the Nandi, Songhor, Muhoroni, and Turbo-Kipkarrent districts, mainly for quality studies. Samples are being collected and will be forwarded in due course for liquoring tests.

SOTIK COFFEE BERRY DISEASE EXPERIMENT STATION

This station has been in charge of a native overseer since my transfer from the Sotik district in March, 1937.

The variety trials are now in full bearing and vegetatively propagated plots are carrying their first crop. In common with most of the Sotik District, the main coffee flowering is in the short rains. In October, 1937, there was an excellent flowering over all the experiments, and a native recorder will be posted to the experiment station during 1938.

(9) *Variety Trials*.—At the Experimental Sub-station at Sotik the variety trials have now come into full bearing. The coffee is at present in a cycle of bearing from short rain flowering, and the Sotik variety trials flowered well in October and December, 1937. It is intended to record the crop in 1938 from these flowerings. Resistance to coffee berry disease is the most important aspect of these variety trials.

(10) *Vegetative Propagation*.—There was no coffee ready for this work at Kepchomo, but observations were made on the Sotik experiments. Due to the humid conditions prevailing for the greater part of the year in Sotik, grafting can be carried out throughout the year with a high percentage of success. Grafting here, in the past, has consisted mainly of experimentation in the technique of the work and, in the absence of recorded parent trees, variety seedlings were used as scion and

root stock. The experiments of special interest will be those showing the influence of root stocks on coffee berry disease. These consist of plots of scions of Mocha coffee, highly susceptible to coffee berry disease, grafted on to imported Blue Mountain root stocks, and of scions of imported Blue Mountain coffee grafted on to susceptible Mocha root stocks. The resistance of the latter, compared with seedling stocks of Blue Mountain, will be of great interest.

(11) *In-arching*.—In Sotik the in-arching of seedlings on to old coffee is an outstanding success, and the experiments prove that existing plantations can be converted to another variety by this method. The advantages of in-arching over grafting are that it is much quicker, requires less experienced labour and consequently is more suited to districts with potential yields near the border line for economic coffee growing. It is only advisable to use it, however, in cases where the seedlings are pure for the characters desired.

GENERAL

Pruning of coffee is in a fairly chaotic state throughout the Nandi district owing to the multiplicity of systems tried in the past. Trials therefore of different types of pruning, mainly starting with the reduction of primaries to 30 to 35 on each bush have been carried out to enable planters to make the best of their "multi-single" stem systems of growing coffee, until such time as they can change over to the proper multiple stem system, which has always been advocated for the higher altitudes of 6,000 to 7,000 feet. At such altitudes it is only possible to grow coffee economically on the multiple stem system, under shade, as there is a tendency towards an over-production of vegetative growth at the expense of crop, leading, on the single stem system, to continual pruning and handling. Furthermore, it is difficult to keep a single stem coffee bush in good shape at the higher altitudes, where it is common to find a good development of lateral growth only on the top of the bush, the growth lower down being whippy, eventually dying back and leaving only a few top primaries to carry the entire crop.

E. COTTINGTON,
Assistant Agricultural Officer.

KITALE EXPERIMENT STATION

The older coffee plots are now coming into heavy bearing; picking being in full swing at the time of writing, it is not possible to give complete results. Unfortunately a severe attack of coffee berry disease and brown blight occurred throughout the plots. The heavily mulched plots suffered particularly severely from dieback through over-bearing.

Variety Trials and Shade Tree Plots.—Picking has been arranged to be done in 48 plots of 24 trees each to enable comparisons to be made between the varieties and the shade and cultural treatments. From the cherry weights available, Blue Mountain, Mysore and Series A appear to be the heaviest yielding varieties. The artificial shade plot is giving the highest cherry weight of the shade plots, followed by the plot of *Acrocarpus fraxinifolius*. This plot has *Calpurnia aurea* as the temporary shade and soya bean as the green manure. The plots under very vigorous temporary shade, in particular *Vernonia* sp. (*Mororowet*) and *Solanum robustum*, have hardly yielded any coffee at all; young coffee cannot compete with these trees. *Grevillea robusta* and *Cordia holstii* also appear to reduce the yield compared with *Acrocarpus*. Cherry weights from the *Ficus sycamorus* plot are very good.

Shade versus No Shade.—This experiment was planted in 1934 and 1935, using three varieties. It is on the multiple stem system and, in addition to the shade treatments, green manuring and permanent grass mulching are being compared. *Grevillea robusta* is the permanent shade, with castor oil as the temporary shade.

The yields of ripe cherry picked this season to date are as follows, each plot comprising 108 coffee trees:—

Cherry, lb.

No shade, mulched	...	...	292.5
No shade, green manure	...	...	198.5
Shaded, mulch	...	...	150.0
Shaded, green manure	...	...	116.5

The three varieties are French Mission Bronze, Series A and Harar. These run the whole length of the treatments and are each three rows wide. The Series A and Harar are just two

years old and therefore not in full bearing. However, the above figures do bring out the controlling effect of shade and that mulching certainly increases yields—though, in the absence of shade, yields reach the point of over-bearing, which is the consequent onset of dieback. This experiment will become interesting as it gets older.

Manurial and Cultural Trials.—During the year experiments were started on five acres of Mr. G. C. A. More's coffee for the purpose of carrying out various cultural treatments with and without bone meal. It is too early yet to obtain any indication of the results.

The Effect of Potash on Quality.—Potassium sulphate was applied to small plots of thirty-six trees each on plantations of M. H. Bentley, Esq., M. V. Hone, Esq., G. C. More, Esq., Dr. E. Granz, L. E. Sale, Esq., T. Little, Esq., H. C. Davidson, Esq., and R. E. Bancroft, Esq. Plots of potassium chloride also are located at Mr. More's and Dr. Granz's. As convenient, samples of parchment coffee from the plots, together with controls of the general crop, are being sent to Nairobi for testing of liquoring quality. No results are available as yet.

M. HALCROW,
Agricultural Officer.

ANNUAL REPORT OF THE PLANT PATHOLOGIST ON COFFEE RESEARCH AT MOUNT ELGON

SHADE EXPERIMENTS

Artificial Shade

As explained previously (Annual Report, Vol. II, 1935, page 6), an artificial shade canopy has been constructed over two acres of established coffee on Kapretwa Estate. This was completed at the end of 1935. The canopy consists of split bamboos, spaced three inches apart. This was made as uniform as conditions and materials allowed and is continuous over the area of two acres.

Observations on Elgon dieback, and records of yields have been maintained since 1934. Thereby figures were obtained indicating the amount of dieback which occurred before the coffee was shaded. In addition, a control plot has also been under observation throughout the same period; it is just outside the area of artificial shade, and can be compared with the shaded coffee.

It is found that this shade had a very definite and beneficial influence in reducing the amount of Elgon dieback. This provides further confirmatory evidence that adequate shade is effective in controlling Elgon dieback disease. The artificial shade has not yet influenced the coffee yields to any marked degree, but sufficient time has not yet elapsed for much improvement to occur. The flowering for the 1936 crop had been formed whilst the trees were still unshaded; this was a year with much overbearing, followed by one of low yields, in which the trees recovered from the previous strain. The crop figures for this experiment will be given later when the influence of the shade canopy has become more pronounced.

Tree Shade

For comparison with the coffee under the artificial shade and also contrasted with coffee in the open, records have been made of yields under the shade of *Musembe* (*Entada abyssinica*) trees.

Trials of Shade Trees

Permanent Shade.

The shade tree plots have been maintained at Muroki Estate (Anderson Bros.). I should like to take this opportunity of again gratefully acknowledging the assistance received from Mr. J. W. Anderson. The shade was planted in

these plots in 1935, and some interesting comparisons can now be made. *Albizzia lophantha* has been found difficult to establish and has made poor growth. Effective shade is already being given by *Grevillea robusta*, and *Acrocarpus fraxinifolius*. These two are the quickest permanent trees yet found, and which are suitable for planting in this district. Other species planted in these plots, but which are much slower growing, are as follows:—

Entada abyssinica.

Ficus (2 species).

Machaerium tipu.

A large-scale field trial is being carried out with two shade trees, *Entada* and *Acrocarpus*. Each of these has been planted throughout ten acres of established coffee at Kapretwa Estate. This should provide useful information as to the practicability of establishing these trees on the *shamba* scale.

During the year, shade was planted in half of the coffee variety trial plots at Kapretwa; so that the varieties may ultimately be observed, each under shaded and unshaded conditions.

Temporary Shade.

Trials are being made of certain quick-growing plants mainly with the object of providing shade for controlling Elgon dieback. For this purpose, two plots are being utilized where the behaviour of the coffee trees in regard to resistance and susceptibility to Elgon dieback was already known. In one case Mororowet (*Vernonia amygdalina*) has been planted and in the other plot another local species (*Vernonia Holstii*) has been used. This latter is expected to provide shade in less time even than the Mororowet, but it is otherwise untried as a temporary shade tree.

SOIL TREATMENTS AND MANURIAL EXPERIMENTS

An experiment was laid down at Kapretwa with the following treatments applied over a total area of two acres. The tree yields are being recorded individually.

Treatments.

1. Boma manure.
2. Bomba manure and bone meal.
3. Green manure (Lupins).
4. Green manure and bone meal.
5. Bone meal.
6. Control.

A similar experiment is being carried out on the following farms:—

Rongai Estate (G. W. Reynolds).

Riverglade Estate (E. J. Lurman and C. R. Tofte).

Kitani Estate (H. Crompton).

Onekana Estate (G. C. A. More).

Qualitative Experiments

The following soil treatments have been applied with the object of observing possible effects on the growth of the coffee. In addition, samples of coffee for liquoring tests are obtained. Yields are not recorded in these treated plots.

1. *Borax*, applied to two plots, each of 36 trees. One plot is situated under artificial shade and the other is in the open. The object is to observe if there is any response of the coffee, due to a previous boron deficiency.

2. *Potash*, applied to four plots, each of 36 trees. These are shaded and in the open and include both French Mission and Blue Mountain varieties. A potash plot has also been laid down at Grohamhurst Estate (F. R. Bancroft).

Samples of the coffee will be taken from these plots to find out whether there is any apparent effect of potash on the liquoring quality of the coffee.

3. *Sulphur*, has been added to the soil of a plot of 36 trees, in 1936 and 1937, the intention being to produce a very acid surface soil and then to observe whether this had any apparent effect on the quality of the coffee. No positive results have been obtained.

4. *Lime*, has also been applied to another plot with the object of producing an alkaline soil for comparison with the results of the sulphur-treated plot.

5. *Ammonium sulphate*, has been given as heavy dressings to two plots of coffee with much leaf yellowing. The object has been to observe whether the appearance of the trees could be improved by means of this fertilizer and to note whether any other secondary effects resulted from the applications of nitrogenous fertilizer.

TREE SELECTION AND RECORDING EXPERIMENTS

A total number of 166 coffee trees are kept under special observation for Elgon dieback and yields are recorded each year, whilst a large number of other trees are noted for disease

resistance alone. In this way, both types and individual trees are selected as having particular characteristics suiting them for various conditions. At the same time seedlings are raised from the various trees so that observations may be made as to the extent to which the progeny retain the characteristics of the parent. Fortunately, the type which is being locally selected for resistance to Elgon dieback gives in the seedlings a very high proportion which are true to type. The seedlings from the resistant type trees can be planted, therefore, in the expectation that they also will be resistant to Elgon dieback. However, vegetative methods of propagation are also being used to obtain clones from particular trees, for use especially in experimental work. A generally satisfactory method has been that of obtaining rooted suckers by ring-barking and then covering with soil.

VARIETY AND TYPE TRIALS

The variety trial plots at Kapretwa were augmented during the year by planting the following varieties:—

1. Amfillo.
2. Geisha.
3. Elgon dieback resistant type.
4. Guatemala selected.
5. Mysore.
6. *Coffea eugenioides*.

The following varieties were already in existence in these plots:—

1. Series A.
2. Harar.
3. Blue Mountain.
4. Plateau Bronze.
5. Coldham's Selected.
6. Kent's.
7. Jackson's Hybrid.
8. Series E.
9. Costa Rica.

Propagation.

(1) *Inarching*.—Since it is found that the seedlings from trees of the variety which is resistant to Elgon dieback come true to type, it is possible to use them for inarching in the field.

A tree which is susceptible to Elgon die-back can readily be improved and converted to resistance by approach-grafting a resistant seedling on to a convenient sucker. This method has been employed most successfully on a small scale and could well be employed on a larger scale where the susceptible type trees may be converted to resistance.

(2) *Grafting*.—Only a few cleft and side grafts were made during 1937. In previous years a large number of grafts had been successfully established. Thereby a number of grafted trees with the following compositions have been obtained:—

<i>Stock</i>	<i>Scion</i>
Elgon die-back susceptible.	Elgon die-back resistant
" " " "	" " " susceptible
" " " resistant	" " " "

Such trees are now used for various observations and comparisons of the growth of suckers and grafted stems.

(3) *Chemical Stimulation of Rooting*.—An experiment was carried out in the laboratory in an attempt to obtain rooting of coffee cuttings, using sand and sand with coco-nut fibre as rooting media. The cuttings were given various treatments, including different combinations of indolyacetic acid in water and in lanolin. No positive results were obtained, except that cuttings remained alive for the longest time when lanolin was applied to cut surfaces. In a further experiment in the field, using lanolin preparations, it was hoped to demonstrate whether there was—

(a) improved callus formation in grafting;

(b) suppression or stimulation of bud development.

Again, no definite results were obtained, but it appeared that lanolin alone and when containing indolyacetic acid, was beneficial when applied to cut surfaces after grafting. This may be perhaps preferable to other materials such as grafting wax. No effect on the development of buds was observed through application of growth-hormone substances.

(4) *Renovation and Replanting Experiment*.—The plots for this experiment were planted during the year and the future programme is as follows:—

(i) Remove old trees and replant.

(ii) Interplant in the rows, old trees removed after one year.

(iii) Interplant in the rows, old trees removed after two years.

- (iv) Interplanting between the rows, old trees removed after one year.
- (v) Interplanting between the rows, old trees removed after two years.
- (vi) Inarching seedlings on to old stocks.
- (vii) Grafting on to old stocks.

(5) *Filling Gaps in Established Coffee*.—The seedlings from particular trees known to be resistant to Elgon dieback have been used as supplies for filling gaps in the plantation. A record is kept of the seedling progeny used in each case, so that comparison will be possible, later, of the vigour and suitability of the seedlings from various mother trees.

ELGON DIEBACK AND COFFEE BERRY DISEASE INVESTIGATIONS

Certain new experiments were commenced during the year as a sequel to the studies carried out by F. J. Nutman ("Bearing of Recent Physiological Research on the Shade Problem in Arabica Coffee Cultivation", *East African Agricultural Journal* II, No. 5, pp. 366-370, 1937). It is sufficient now to indicate briefly the objects and results of new experiments and observations made in the study of Elgon dieback and coffee berry disease.

Defoliation Experiments.—It is possible to create a carbohydrate deficiency in parts of a coffee tree by removing all the leaves, since they are the essential manufacturers of this material. The promptitude with which a deficiency may arise, will depend on the amount of reserves present in the stems, and therefore not removed with the leaves, and also on the extent to which such reserves are being mobilized by the plant in respiration and for supplying the berries.

Typical symptoms of Elgon dieback can be produced by such defoliations, and even in a shaded tree when the demands on carbohydrate reserves are very great.

Growth observations.—The reason why different types of Arabica coffee are relatively resistant or susceptible to Elgon dieback has received at least a partial explanation. Observations have been made on a large number of trees at intervals of ten to fourteen days. Notes are then made on the production of new leaves and primaries. When these observations are suitably depicted graphically, a comprehensive picture results comparing the growth of various types of coffee under different conditions. Apparently Elgon dieback is associated with a particular and prodigal manner of

growth and where leaves are lost prematurely. These are, in fact, the same conditions as are brought about by experimental defoliation, which also produces dieback symptoms. This disease, however, does not occur where growth is more efficient and there is less wastage of material on account of the leaves persisting for a longer period.

Ring-barking Experiments.—Another series of experiments has been initiated in which the opposite effect to that of defoliation is the aim. The result of removing a ring of bark from the stem is to cause an accumulation of carbohydrate whilst defoliation produces a deficiency. Ring-barking is a time-honoured method of increasing fruitfulness in various trees. It is too early yet to foresee what the ultimate effects will be in the case of coffee, but it is evident that flowering may be stimulated by ringing the stem. If this could be done safely and without other evil consequences then it might be a valuable assistance in districts where flowering is insufficient or frequently suppressed. In addition to causing an actual accumulation of carbohydrate above a ring in the stem, this may also be considered rather as an alteration in the normal proportions of nitrogen and carbohydrate in the plant. It has been thought that coffee berry disease may be itself associated with a condition of lack of proper balance in the carbohydrate and nitrogen in the plant. This problem is now being studied by using the experimental methods described above, such as defoliation and ring-barking, in order to bring about various proportions of carbohydrate and nitrogen in the coffee tree. In this way it is hoped to find out a suitable method for achieving a proper balance in the plant, in cases where diseases appear to be the result of some disturbance in the ratio of carbohydrate and nitrogen.

C. A. THOROLD,

Acting Senior Plant Pathologist.

ANNUAL REPORT OF THE SOIL CHEMIST ON INVESTIGATIONAL WORK

The Phosphate and Potash Status of the Kikuyu Red Loam

Accounts of the progress of laboratory investigations on the phosphate status of the major coffee soil type have appeared in the annual reports for a number of years. Further work carried out during the year under review has dealt with phosphate reserves contained throughout the soil profile down to ten feet and over. A new standard method of analysis was worked out using cold semi-normal sodium hydroxide as the phosphate-extracting medium. This method breaks up phosphoric oxide held in the form of complex iron and aluminium compounds and gives information illustrating the distribution of phosphate reserves throughout the depth of the feeding roots of the coffee tree. This work shows that, beyond the darker surface soil where relatively much phosphate is held by the organic matter, there is no sharp falling off in the phosphate reserve of the soil, and that there is in fact a tendency towards a small natural increased accumulation of phosphate beyond about the ninth foot and which extends to the limits of samplings at the Scott Agricultural Laboratories. Some analytic data of a typical red coffee soil profile will illustrate this: The upper six inches of soil contained .061 per cent phosphate reserve expressed in terms of phosphoric oxide. The second six inches contained .026 per cent; the third six inches contained .020 per cent and the fourth six inches contained .016 per cent. This content then gradually fell off to a minimum of .009 per cent at about the eighth foot and then gradually increased again to .013 per cent at the limit of the depth of sampling at fourteen feet. The natural distribution of phosphate reserves throughout the soil profile appears to be the resultant of gradual downward leaching and the upward movement brought about by the natural vegetal cover. This has resulted in an accumulation in the darker surface soil and in the immediate sub-soils which have received the litter mineral residues brought up from lower depths by plant roots. This zone has also received accumulations due to continuous decay of more abundant plant roots. The small increase of phosphate at the lower levels is probably due to a scarcity of feeding roots for the upward movement of this plant nutrient. This work illustrates the importance of preventing the removal by slow erosion of the valuable surface soil and shows that applied phosphates remain as reserves in the upper soil.

Laboratory investigations on the potash status of the lava-derived red coffee soils have confirmed previous work that these soils are well supplied with potash reserves and also that there is much potash in a very available form. Past analyses of over fifty representatives of such soil samples, carried out by standard methods of analysis, had shown most of these soils to contain very high amounts of available potash. The values were of the order of .03 per cent to .06 per cent as compared with .01 per cent to .02 per cent for other fertile soil types. In more recent investigations, a range of smaller and weaker extracting media were used. This showed only a small falling off in potash extracted with these weaker solutions, and furthermore the greater portion can be removed in small initial leachings. Subsequent empirical work showed that when soluble potassium salts are added to the soils, these are loosely held such that most of the added materials can easily be extracted again. Both these investigations show that the red coffee soils have large amounts of very available potash and indicates that the potash contained in normal applications of organic manure is sufficient to maintain this suitable potash-status in most cases. In well-manured old lands there is usually more available potash than in similar soils in the early years of cultivation. The above remarks pertain to most of the deep, lava-derived red loams of the Central Province. The sandy red soils derived from the Basement Complex show relatively lower values for potash and here the application of cheap wood ashes is recommended. It is proposed that similar soil phosphate and soil potash studies on such soils be included in the future programme of soil investigational work.

Water Pollution

The need for the reduction of the pollution of bodies of water by coffee factory effluents is now recognized by the general community, more especially those situated in the lower reaches of the smaller streams in the Kiambu District. The major task is not only that of reducing absolute pollution but that of bringing about a reduction in pollution that is compatible with the minimum loss of water. The necessity of removing the maximum amount of solid coffee pulp waste by suitable methods has long been stressed, and an increasing number of estates have improved their separation methods. There is still need to arrange the better reposition and the clearing of the waste pulp heap such that no flow of water drains through it. A report of initial laboratory work dealing with fermentation effluents appeared in the *Coffee Board*

Bulletin for August, 1937. It was suggested that fermented coffee be stirred or washed in the tanks and that this thick washing be diverted from the main washing channels and allowed to flow into seepage pits. Similarly with the second washing. As the greater portion of the fermenting waste matter has thus been removed, the subsequent fairly clean washing could be allowed to return direct to the stream. During the latter part of the year, a more detailed field and laboratory survey of this pollution problem has been carried out in conjunction with Major Carrick of the Public Works Department. The volume of water used for the different factory processes under four representative factory conditions has been measured; also the percentage of coffee factory waste matter, and hence the weight of waste matter contained in these different flows. The total waste matter contained in the different factory effluents amounted to about 6 cwt. of dry matter per ton of prepared clean coffee and rather more than half of this is contained in the pulp-carrying water. The greatest concentration of waste matter is contained in the initial washing water and the main tank effluent. These flows remove more than a third of the total waste matters in about an eighth portion of the factory water used. A full report of this work, together with specific recommendations, will be submitted in due course.

*Coffee Quality—The Possible Influence of Associated
Micro-flora on Coffee Liquor*

Certain accounts of reported successful investigations carried out by Dr. Rogerio da Camargo in Brazil and by Dr. C. Ricardo in Costa Rica prompted initial work on the possible effects of associated micro-flora on the liquoring qualities of East African coffees. A summary prepared by me of the American work and its possible application to local coffees appeared in the issue of the *East African Agricultural Journal* for August, 1937. Initial work was carried out by Dr. Case, the Bio-Chemist to the Coffee Board of Kenya. In co-operation with Mr. Devonshire, the Board's liquorer, he selected and prepared numerous yeast or yeast-like cultures from samples of good, unclean and foul coffees. On Dr. Case's departure this work was taken over by me and after multiplying the mass of selected cultures a series of tests was arranged so that cultures of known sources were added in the preparation of different coffees. Three lines of approach were made to test out whether the addition of such cultures could have any appreciable effect on the liquoring qualities of milk coffees. The pure culture was added to freshly

pulped beans to test the effect of the presence or possible growth of different cultures during fermentation. Again, sugar solutions of yeast cultures were sprayed on to freshly picked cherries and the latter then allowed to dry as *buni* coffee. Thirdly similar suspensions of pure yeasts in sugary solutions were sprayed on to ripening cherries on the trees and then the treated cherry was dealt with both by the *buni* and by the wet method of preparation. There were adequate controls of all treatments throughout. Excepting for the addition of different pure cultures, every effort was made to give all samples the most uniform feeding treatment possible. The total number of treatments including control, amount to sixty-one coffee samples, involving the use of five selected yeast cultures. The liquoring tests have not yet been completed.

Soil Survey of the Karimani Experimental Station

The analyses of the soil profiles taken from adjoining areas of well-manured coffee of different ages showed that there had neither been any appreciable increase nor falling off of the total nitrogen reserves in a fairly light soil even after fifteen years of coffee cultivation. As very large applications of bulky organic manures containing much nitrogen had been added to this land, these comparative analyses illustrated the difficulty of raising the organic matter and nitrogen contents of a cultivated soil to above its natural level. On the other hand, such a soil would certainly have deteriorated had manuring by green manure growth and the application of bulky organic manures been omitted. Similar analyses of the same soils showed that the manuring carried out had produced a marked increase in the available potash content of the old-established coffee lands as compared with the adjoining virgin land.

Trials of Boron

Small scale observational manurial trials with borax as a source of boron given at the rate of 40 lb. per acre have been laid down on coffee in several districts. At this rate of application, there have been no harmful effects after nine months, and more extended trials will therefore be carried out.

G. H. GETHIN JONES,
Soil Chemist.

ENTOMOLOGICAL WORK ON COFFEE

MEALY BUG INVESTIGATIONS

Dr. Le Pelley's report on work in the Orient

At the beginning of the year I was working in the Philippine Islands from which I sent one shipment of enemies of *Pseudococcus lilacinus* in January and two in February. In February I left for Java and spent three-and-a-half months in the Netherlands Indies, sending thirteen shipments of insects. I visited Malaya, Ceylon and South India, sending one shipment from Ceylon and three from South India, returning to Kenya in September. The parasites and predators received alive in Nairobi numbered over 7,500. The results of the project are summarized.

(1) The Kenya coffee mealy bug was not identified during the extensive collecting done on the journey. It is certain that it is not a common insect in the Orient and it is probably quite safe to assume that it is not present there. The large collections of mealy bugs made, of which only a proportion could be studied microscopically on the journey, will require identification before a completely definite statement can be made.

(2) No one of the several species of primary parasites of *Pseudococcus lilacinus* which were successfully shipped to Nairobi would attack *Pseudococcus kenya*e. It should be stated that the Kenya mealy bug proved not only resistant but actually immune to attack of the parasites, none of which would oviposit in it.

(3) A number of predators including a *Cecidomyid* from the Philippines and *Coccinellids* from Java, Ceylon and India were reared for a number of generations in Nairobi, but owing to the differences in temperature between Nairobi and the localities from which they were sent, all the species bred very slowly, and it was not possible to build up large stocks of any of them. Some field liberations of certain species were made, but it is not anticipated that these insects will become established.

Reasons for the negative results may be briefly mentioned:—

(i) After my determination in 1935 that the Kenya mealy bug was not identical with *Pseudococcus lilacinus* it was realized that, owing to the high degree of specificity of many mealy bug parasites, the prospects of obtaining

an efficient parasite for the Kenya insect were less promising. The decision to continue with the project was made on the assumption that, despite the differences between them, the insects were closely related, and that one or more parasite species might transfer to the Kenya insect.

The observations made on the journey however added considerably to our knowledge of *Pseudococcus lilacinus* and we now know that there are not only morphological differences such as were brought out in my original description of *Pseudococcus kenyae* (Stylops, August 1935) but also a number of important biological differences details of which it is proposed to publish elsewhere at a later date. The conclusion drawn, as a result of this further knowledge, is that *Pseudococcus lilacinus* and *Pseudococcus kenyae* are not so closely related as was previously thought, and the difference between them was demonstrated conclusively in practice by the fact that the Kenya mealy bug proved completely immune to all the primary parasites of the other species received in Nairobi.

(ii) With reference to the predators—of which a number of species have been reared—on the Kenya mealy bug, the chief factor limiting their usefulness is temperature and to a lesser extent probably, humidity. *P. lilacinus* is an insect that does not live ordinarily (if at all) above 3,000 ft. elevation, and in the Philippines and Java its environment is marked by high humidity. The conditions of prolonged high temperatures and high humidities are not paralleled in Nairobi, and so we find, for example in the case of *Scymnus apiciflavus* from Java, that the insect takes approximately three times as long in Nairobi to complete its development, from egg to adult, as in its native home.

RECEPTION AND TRIAL OF PARASITES AND PREDATORS OF *Pseudococcus lilacinus* FROM THE ORIENT

Mr. Melville's report on work in Kenya

From the beginning of the year until September the main project was the reception and trial against *P. kenyae* of parasites and predators of *P. lilacinus* sent by Dr. R. H. Le Pelley, who was collecting in the Orient. Shipments of material were received from Hawaii, Japan, the Philippine Islands, Java, Ceylon and India. All shipments were opened

in the quarantine insectary at the Scott Agricultural Laboratories and experiments to determine whether the natural enemies of *Pseudococcus lilacinus* would attack *Pseudococcus kenya*e were also conducted in this insectary.

In general the condition of the material on arrival was excellent and natural enemies of *P. lilacinus* were obtained in sufficient numbers to enable adequate experimentation to be carried out. A large number of species of internal parasites were tested in an exhaustive series of experiments but no one of them would attack *P. kenya*e. It was found to be possible to breed some of the predators of *P. lilacinus* on *P. kenya*e. A species of *Cecidomyid* from the Philippine Islands, *Scymnus apiciflavus* from Java, two species of *Scymnus* from Ceylon, and two species of *Scymnus* from South India were bred and liberated in Kenya, but they are not expected to be of any great value, because under the climatic conditions experienced in Kenya these insects breed extremely slowly.

Introduction and establishment of Schizobremia coffeae

Some time ago material containing *Schizobremia coffeae*, the larvae of which are predators on mealy bug, was obtained from Bukoba in Tanganyika. This midge was bred in large numbers in the insectary during the early part of the year and seven large liberations were made at representative points in the mealy bug area, double liberations being made at two places.

The insect was later found to be breeding at the site of two of the liberations, namely, in the district of Donyo Sabuk and Kiambu. It is possible that this insect will now establish itself and play some part in the control of mealy bug.

Trial of mealy bug parasites from the Belgian Congo

Through the courtesy of M. J. Ghesquiere, Chief of the Division of Phytopathology in the I.N.E.A.C., who sent material from the Kivu district of the Belgian Congo, it has been possible to test out certain mealy bug parasites against *P. kenya*e. Only one of the species tested could be induced to oviposit in *P. kenya*e. This parasite (at present unidentified) was obtained from an undetermined species of *Pseudococcus* on *C. arabica*. This species oviposited readily in *P. kenya*e, but this mealy bug was practically immune to their attack, the eggs of the parasite within the mealy bug being killed by the action of phagocytes. A very small percentage of parasites were bred through on *P. kenya*e. The knowledge

acquired on these lines, however, along with other aspects of the biological control problem, has been fully dealt with in an article prepared for the *East African Agricultural Journal* for March, 1938. This article refers chiefly to coffee but details of the incidence and pest status of mealy bug in the native reserves will be found in a departmental report.

Briefly it may here be said that further evidence collected has been placed beyond doubt that *P. kenyae* is an introduced insect in the Central Province, and a survey showed that while certain parts of the Province are not yet affected the area which may be expected to become affected through the natural spread of the insect cannot be estimated. This area is surrounded by ecological barriers, such as thorn scrub savannah country and mountains, and in respect of the mealy bug it is an ecological island. This fact is considered to increase the likelihood of successful biological control. Other such ecological islands have been shown to be present south of Mount Kilimanjaro and Mount Meru in Tanganyika Territory as a result of a survey in that territory, though the insect is not now present in them, and owing to the barrier country surrounding them is not expected to reach them by natural spread.

The biological control programme will be continued by an investigation of the status of *P. kenyae*, i.e. whether introduced or indigenous, in Uganda, the lake area of Tanganyika in the vicinity of Bukoba, and in the Belgian Congo; with the possibility of discovering there some valuable natural enemies of the mealy bug.

A Study of other Pseudococcinae and their natural enemies in Kenya

An advance has been made in the collection of parasites and predators of other *Pseudococcinae* in Kenya. It is essential that such knowledge of local insects be obtained at present for these insects will form the groundwork upon which any other natural enemies subsequently introduced will be superimposed. This study has already proved of interest because it has been found that certain internal parasites, which can in rare cases attack *P. kenyae*, are important parasites in other hosts and these have been able to develop in *P. kenyae* because the resistance of this species to their attack is not sufficiently great to confer complete immunity. The total attack on *P. kenyae* by about four or five species of primary internal parasites amounts to less than 1 per cent.

The pest status of mealy bug during 1937

During the latter months of 1936 and the early months of 1937, the Common Coffee Mealy bug (*Pseudococcus kenyae*), caused a considerable amount of damage in coffee plantations in the Central Province. The period referred to was characterized by a shortage of rainfall and conditions generally were much hotter than usual. Many serious outbreaks of mealy bug occurred during this time even though banding was efficiently carried out, the position being aggravated by the fact that the predators were unable to make any headway against the pest. This was found to be due chiefly to the predominance of certain parasites of these predacious insects which were present to such an extent that the predators were prevented from multiplying in sufficient numbers to control the mealy bug. The lady-bird, *Hyperaspis senegalensis*, for example, was found to be parasitized to the extent of 80 per cent in some cases. The reason for the increases of parasitism of this species is obscure, but it is probably connected in some way with the unusual climatic conditions prevailing at the time. With the onset of the long rains, however, this state of affairs rapidly altered and predators bred up in sufficient numbers to control the mealy bug. There was little further trouble from mealy bug in coffee during the remainder of the year. Many planters, however, took advantage of the improved predator populations after the rains in order to thoroughly clean up mealy bug outbreaks by efficient banding.

A certain amount of work has been carried out in the native reserves of the Central Province where this same mealy bug, *P. kenyae*, is a serious pest of yams, pigeon peas, cotton and several other crops. In September and October a number of severe outbreaks of mealy bug were found on these crops in the reserves.

Ecological Studies on Pseudococcus kenyae and on the Ant Pheidole punctulata

Most of the investigations on conditions influencing outbreaks of mealy bug were done at the higher altitudes because it was felt that any differences dependent on ecoclimatic conditions in the plantations would be more clearly demonstrated at such altitudes. If mealy bug outbreaks, for example, could have been attributed to slightly warmer conditions occurring locally in such places as hollows, leeward slopes, etc., it would have been possible to attempt to prevent outbreaks, for example, by the use of shade in such places. It was found, however, to be impossible to correlate mealy bug outbreaks

with any known local factor whatsoever. Outbreaks were encountered in a variety of positions such as on the top of ridges, on various exposures, in sheltered places, on various soil conditions and in shaded and unshaded coffee.

It was found that the one factor common to all serious mealy bug outbreaks was the presence of the ant *P. punctulata*. The presence of this insect would seem to be the critical environmental factor. This does not deny the fact that an increase of temperature increases the rate of development of the mealy bug. That it does so is undoubtedly true but when two species of insects are necessary to the production of an outbreak the local conditions influencing both of these insects must of course be considered. It is possible to imagine a set of conditions in the coffee trees favourable to the mealy bug and another set of conditions in the soil favourable to the mealy bug and another set of conditions in the soil favourable to the ants. When these overlap it may be said that a serious outbreak may be expected. Theoretically, it would appear that at the absolute limit for both mealy bug and ant, outbreaks can only be expected at points where the two sets of conditions overlap, but in actual practice in the greater part of these high coffee areas the ant seems to be able to produce an outbreak in any situation. In other words the ant, if present, is capable of overcoming any local disadvantage which the area may possess as regards the mealy bug and of producing an outbreak.

If the chances of combating mealy bug in these high areas by altering its environment are small, they are much smaller in the lower areas where *P. kenyae* develops much more rapidly owing to higher temperatures and to more vigorous attendance by *P. punctulata*.

Several planters have reported that the outbreaks tend to recur in certain areas and it seemed possible that some local factor might be responsible for this state of affairs. The survey referred to above has shown that the presence of *P. punctulata* is the critical factor. The explanation of such recurrent outbreaks as occur is frequently that the mealy bug remains in the area in small quantities even after banding has been employed and the outbreak has been "cleaned up". Mealy bug may exist for a long time in the crevices of the bark below the bands being attended by ants in this position and ready to initiate a fresh outbreak when suitable conditions arise. On this account the treatment of the trunk with lime wash or some other insecticide after an outbreak has been controlled, is strongly recommended.

The importance of the ant *P. punctulata* has been referred to and it is evident that more knowledge is required about the ecology of this insect. There is a certain amount of observational evidence to show that in some plantations there are areas in which *P. punctulata* seems to be prevented from becoming a dominant species. No reason for this state of affairs can be given and a preliminary experiment has been laid down at the Karimani experimental station with a view to studying the ant under various soil conditions. The ant will be studied under a series of nine different soil treatments including mulching, heavy *boma* manuring, green manuring, bare soil, etc. The experiment has no replications but will allow of the collection of a certain amount of data which will be of use later for the laying down of a more comprehensive experiment if such is proved to be justified as a result of this preliminary experiment. Before the soil treatments were commenced in the individual plots, *P. punctulata* was found to be present in each pot. Observations on the behaviour of *P. punctulata* will be carried out at frequent intervals during the course of the experiment and soil conditions in the plots will also be compared from time to time.

BANDING GREASE TRIALS

In March the Coffee Board of Kenya received a complaint in respect of the quality of banding greases from the Thika district. The matter was handed over to the Coffee Team and it was decided to carry out a trial of all banding greases at present on the market in Kenya as well as any greases in an experimental stage, with a view to determining the quality of the various greases.

The trial has been conducted at the experimental station on Karimani Estate, Thika.

The greases were thoroughly tested over a five-month period from early August and observations were made regularly under a wide range of conditions, e.g. cold, hot, and wet weather, during cultural operations, etc. No laboratory tests have been conducted, the aim being as stated above, to ascertain the behaviour of the various greases under plantation conditions. Six coffee trees were banded with each grease and observations were made on the following lines:—

- (i) the effectiveness of the greases against the ant;
- (ii) the behaviour of the greases under varying climatic conditions, i.e. hardening, running, drying up;

- (iii) the length of life of the bands before (a) restirring,
(b) renewing was necessary;
- (iv) any obvious damage caused to the coffee trees by direct banding.

A summarized report on these trials based on the observations of Mr. T. M. McClelland, in charge of the station, who actually conducted them, has been published in the Coffee Board Bulletin for February, 1938, and each firm concerned has received a detailed report on each banding grease submitted for trial. The value of the trial was shown by the fact that a number of the greases submitted proved to be unsatisfactory, while on the other hand several greases proved excellent products capable of stopping ants for several months without further attention after the application. The effect of a preliminary application of Melanoid paint was disappointing. Greases applied over Melanoid dried up more quickly than when applied direct to the bark.

OTHER INVESTIGATIONS

Experiments with Argentine Ant Poison Bait

(a) Experiments were carried out with an Argentine ant poison bait as a poison bait for the mealy bug ant *P. punctulata*. This bait was supplied to colonies of the ant kept in deep battery jars and although the ants fed vigorously on this poison bait for about half-an-hour they subsequently avoided it entirely. Numerous attempts have been made in the past by various members of the Department to find a suitable bait for use against *P. punctulata*, but this ant appears to possess a high degree of "intelligence" and is able to detect the presence of a poison quite readily. The baits are taken to begin with but are subsequently left entirely alone. Although it is possible that a more suitable poison than that already experimented with may be discovered this method of attacking the ant does not seem to hold much promise.

Tests of Sprays

(b) Several experiments with sprays have been conducted during 1937 but none of the sprays tested has been found to be really efficient against mealybug. In general it has been found possible to kill the outer layer of mealy bug in a cluster but the waxy nature of the insects does not allow of the penetration of the spray to the layers underneath. Consequently several applications of these sprays are necessary to approach control. Although this procedure may be justified in a small localized outbreak its cost will be prohibitive when large areas have to be treated.

A New Ant

(c) Mr. Lloyd, of Kitamaiyu Estate, Ruiru, reported that a small ant had been found to be nesting in tunnels bored under the grease bands on coffee trees. The ant was subsequently collected but has not yet been identified. The importance of this ant lies in the fact that its excavations are ultimately used by mealy bug ants (*P. punctulata*) to gain access to the trees. This can of course only be accomplished when the excavations extend from the bottom to the top of the band. This new ant seems to be fairly common and its presence adds to the difficulties of grease-banding. When these ants are discovered, the tree must be rebanded and care must be taken to rub off the loose flakes of bark before applying the new band because it is in this dead bark that the ants make their tunnels. This ant is probably quite widespread and if mealy bug ants are found on coffee trees when all other means of their reaching them have been removed, then the presence of this new ant should be suspected.

An outbreak of Pseudococcus citri

An outbreak of *P. citri* on coffee was discovered in the Machakos district. This mealy bug is rarely seen in outbreak form. The outbreak referred to occurred in an area not yet infected by *P. kenyae*. *P. citri* has always been and is still regarded as a minor pest.

Antestia

Work was continued on the bionomics of *Antestia*, and Dr. R. H. Le Pelley resumed charge on his return to Kenya in September.

This work was a continuation of the study of *Antestia* bionomics which had been planned early in 1934 as one of the major projects recommended to be recognized as such by the Amani Conference on Co-ordination of Agricultural Research and Plant Protection, February, 1934, and which has been continued uninterrupted up to the present. Considerable further information on the bionomics of the insect under field conditions was obtained during the year along the same lines as have been published in previous annual reports.

PART VI—BOTANICAL SECTION

A.—ANNUAL REPORT OF THE ACTING SENIOR PLANT PATHOLOGIST

STAFF

Mr. J. McDonald left Kenya Colony on home leave on the 3rd April, 1937, and was transferred to Cyprus on promotion as Director of Agriculture with effect from November 31st, 1937. Throughout the year since his departure I have been Acting Senior Plant Pathologist and carried out duties accordingly, whilst continuing to have my headquarters at Kapretwa Estate, Mount Elgon. This was made necessary by my additional capacity as Plant Pathologist in the Coffee Team, in order to continue investigations on Elgon Dieback and Coffee Berry Disease.

Mr. D. C. Edwards, Agricultural Officer in Charge of Grassland Improvement, was absent on home leave during the year from 16th March to 11th December.

Mr. E. Cottington, Plant Inspector, was locally in charge of the Coffee Berry Disease Experiment Station at Sotik and later at Kepchomo Estate, Nandi, when the experimental work was transferred there. At the beginning of the year Mr. Cottington joined the personnel of the Coffee Team.

Mr. F. W. Evans, Junior Laboratory Assistant, carried out general laboratory work including the maintenance of pure cultures of fungi and the management of the mycological herbarium and was solely in charge of the wheat stem rust work at the Scott Agricultural Laboratories. Additional duties included the charge of the central library at the Laboratories and indexing the literature of the Botanical Section.

A native Agricultural Instructor, trained at Bukura School, was engaged in December, 1937, in order to assist me in routine coffee work at Kapretwa Estate.

MEETINGS

I visited Nairobi in January for the Staff Conference on the 20th and 21st and to take part in the deliberations of the Coffee Team.

I attended a committee meeting of the Trans Nzoia Coffee Planters' Association on 21st May and a meeting of the subscribers to the Coffee Experiment Fund, at Kitale, on 19th November.

FIELD DAYS

These were held and attended as follows:—

May 21st.—Kapsajoi Estate, Turbo (Commander R. K. Philpot), where I gave a talk on coffee diseases.

June 30th.—Kapretwa Estate, Mr. S. Gillett gave an address on local coffee topics.

August 14th.—Department of Agriculture Plots, Kitale.

This was followed by a meeting of the Trans Nzoia Coffee Planters' Association.

TOURS AND EXTENSION WORK

Various farms in the Trans Nzoia were visited during the year both by request and for particular purposes such as inspection or investigations in connexion with Elgon dieback and coffee berry disease.

Two tours during the year were made in Nyanza Province, in order to observe the extent of diseases such as berry disease and leaf disease (*Hemileia vastatrix*) and to see the progress of the experiments being carried out in various districts. January 25th to 29th, I visited estates in Muhoroni, Songhor, Nandi, Turbo and Kipkarren, similarly July 2nd to 12th, including a visit to Kaimosi.

March 22nd to 27th I visited Uganda and there discussed various coffee matters with Mr. A. S. Thomas and other officers of the Uganda Department of Agriculture at Kampala and at Entebbe. Mr. Thomas kindly showed me his work at the laboratories and elsewhere. On my return journey to Kenya I stayed at Bubulu. There the Agricultural Officer in charge of the Bugishu Coffee Scheme kindly showed me much of interest, including the field experiments at Bugusege. I wish to thank the Director of Agriculture and various officers of the Uganda Department of Agriculture for assistance and hospitality which I received during this visit.

July 21st to 29th. I visited Tanganyika and spent several days at Amani and Lyamungu in seeing work in progress in the laboratories and in the field. It was of very great value to me to have opportunities during this tour of meeting officers engaged in work on coffee in particular, in Tanganyika Territory. I wish to take this opportunity of thanking the Director and his staff at Amani and at Lyamungu for the hospitality and kind attention which I received during this visit.

VISITORS

Visitors from outside the Colony to Kapretwa Estate during the year included Mr. E. Harrison, late Director of Agriculture, Tanganyika Territory, and Messieurs Steyaert and Vrydagh, Mycologist and Entomologist respectively in the Belgian Congo.

PLANT PROTECTION SERVICES

Since Mr. McDonald's absence and on account of my being stationed on Mount Elgon, it was arranged that specimens for examination and enquiries concerning plant diseases, excluding matters regarding insect pests, were sent to me for attention.

The administration of the Plant Protection Services, including the issue of permits for importing planting material, was attended to by Mr. H. Wilkinson, Entomologist in Charge, at the Scott Agricultural Laboratories.

The Diseases of Plants Prevention Ordinance (Chapter 155 of the Revised Edition) was repealed and in its place a new legislation under the short title "Plant Protection Ordinance, 1937", received assent and commenced on 28th August, 1937, with an Order and Schedules of Diseases and Insect Pests published as Government Notice No. 687 on 7th September, 1937.

A consignment of apple trees was destroyed at importation on account of the unhealthy condition of the root system. It was not possible to assign any specific disease although the appearance suggested Crown Gall and "Hairy Root" symptoms. Nevertheless it was considered that this condition prejudiced the successful planting and cultivation of this material and that it was in the best interests of the consignee and of the Colony in general that the trees should be declared as "diseased" and accordingly destroyed. It is provided in the Ordinance that "disease" means any unhealthy condition of any plant and such can accordingly be authorized by an inspector to be destroyed.

INVESTIGATIONAL WORK

Since April, 1937, when Mr. McDonald left the Colony, I have had to combine duties as Acting Senior Plant Pathologist with those of my position as Plant Pathologist in the Coffee Team. This has resulted in some difficulty in apportioning my time to the best advantage in this dual capacity. There have inevitably been occasions when one or other

of the interests concerned has had to suffer. It has been virtually impossible to devote time to investigational work on crops other than coffee. I can therefore only record with regret certain diseases which have required more study than it has been possible to devote to them in the circumstances. It is to be hoped that they will be able to receive their proper share of attention at some future time. No mention is made in this report of investigational work concerned with coffee; this is considered elsewhere in the report of the Officer in Charge of the Coffee Team.

WHEAT

The work in connexion with stem rust at the Scott Agricultural Laboratories was solely in the charge of Mr. F. W. Evans, who carried out these duties most satisfactorily. He reports on this work as follows:—

“Duplicate pure cultures of the four physiologic forms of stem rust were maintained at the Scott Agricultural Laboratories throughout the year.

A small plot of Kenya Standard wheat (growing in the mixed farming exhibit) was artificially infected with Form K4 for the Agricultural Show held in Nairobi in June. The infection took well and at the time of the Show the plot of Kenya Standard wheat was heavily infected with stem rust while a similar plot of 58.F. (L.1) growing alongside, showed no trace of rust.

An artificial epidemic of all four physiologic forms was produced in the Plant Breeder's cage on rows of Reward wheat surrounding various hybrids undergoing test. There were thirty-two rows of Reward wheat and a heavy infection was produced on all of them. K1 and K4 made their appearance first and predominated throughout but the other forms (K2 and K3) made their appearance later.

No natural infection of wheat stem rust occurred at the Laboratories during 1937.

Sixteen rust samples from different parts of the Colony were tested to determine the form present and a summary of the distribution of fifteen of them is given below. One sample is still undergoing test and results are not expected until 21st February.

- K1. Njoro—December.
- K2. Kinankop—January and October.
Menengai—February (Trace K4).
Rongai—February.
Njoro—July and December.
Narro Moru—July.
Eldoret—November.
Kitale—December.
- K3. Nil.
- K4. Kinankop—January.
Rongai—January.
Menengai—January.
Nakuru—January.
Njoro—July.

In addition the presence of a suspected new form (K5) was recorded on 58.F. (L.1) from Njoro in June and from Ol Kalou and Kitale in December. Numerous tests to determine the nature of the reactions of this rust on the differentials have been undertaken while others are still in progress. Briefly, the majority of these tests have shown the following reactions:—

- Kenya Governor—Resistant.
- Einkorn—Resistant.
- 112—Susceptible.
- Reliance—Resistant.
- Kenya Standard—R-S. (border line).
- 58.F. (L.1)—Susceptible.

Only one wheat (Douglas/M/1) was tested in the seeding stage for reaction to the four physiologic forms. It proved to be resistant to all of them. Nine hybrids were tested with the suspected new form.”

GRANADILLA

I examined specimens of vines submitted to me as suspected of showing symptoms of “Brown Spot”. It was not possible to confirm this disease as definitely present, although a species of *Gloeosporium* was noticed during the laboratory examination of the material. The exact identity of the fungus responsible for “Brown Spot” seems to be in doubt. This disease has been variously attributed to *Alternaria*, *Macrosporium*, and *Gloeosporium*.

I advised that for practical purposes it should be considered that it was this particular disease that was occurring, therefore, that recommendations in regard to spraying and pruning should receive attention.

Another important disease of granadilla known as "Woodiness" is also believed to be present in Kenya Colony. This is a virus disease in which unfortunately the symptoms in the early stages are obscure, consequently the disease often escapes notice for some time. Ultimately the fruit develops a thick woody rind as a result of this disease.

PYRETHRUM

A condition in which the petals become discoloured and flowers wither prematurely, has occurred on a farm on Mount Elgon and also apparently elsewhere in the Colony. I have examined this "disease" in the field and found that the affected flowers were invariably infested with thrips. These insects were examined by the Entomologist who reported that they were all in the nymphal stage. Specimens previously collected from Pyrethrum had been identified as *Thrips tabaci* Lindeman. It was recommended that the Pyrethrum should be sprayed with Lime Sulphur (1 in 30) before the flowers opened, also that a sulphur fumigation might be experimented with on a small scale. This "disease" is not yet under control and the matter requires further study for the aetiology to be completely understood.

COTTON

Arcolate Mildew (*Mycosphaerella* (*Ramularia*) *areola*) was reported as serious in the Coast Province in 1936 and 1937. It is very unlikely that this disease alone would be responsible for the low yields obtained. It is probable that some other cause is more directly concerned. It would necessitate a thorough investigation of the crop in the field in order to determine the factors underlying the recent partial failures of the crop.

DISINFECTANT DUSTS

A new proprietary product Agrosan G. together with two experimental samples were kindly supplied by Dr. T. Callan of Imperial Chemical Industries, Ltd., Dyestuffs Group. These preparations were used in experiments with barley for the control of Head Smut and on flax as a seed dressing.

BARLEY COVERED SMUT

This trial was carried out by Mr. Evans at the Scott Agricultural Laboratories. Smut spores (3.5 grams) were thoroughly mixed with barley seed (1,400 grams). This was then divided into four lots, one of which remained as control and the other three were each treated with one of the three disinfectant dusts referred to above. The four lots of seed were then sown in replicate as 25 rows each 36 ft. long, with two additional border rows. Very little smut developed in this experiment and infected ears occurred in six of the thirteen control (untreated) rows only. In these there was an average of seven smutted ears per row. The percentage of infected to healthy ears in a whole row did not exceed 1.5 per cent and was in several cases of the order of a hundredth of 1 per cent only.

All the disinfectant treated rows were free from smutted ears. Therefore, all the treatments gave equally good control but no comparison can be made between the three different preparations on the basis of this experiment.

LINSEED

An experiment was carried out by the Agricultural Officer at the Plant Breeding Station at Njoro, on the use of three mercurial dusts for treatment of linseed (variety Redwing) before planting. Agrosan G. and the two experimental preparations all gave increased yields over the control. This improvement was statistically significant in cases of dusts Rd. 8521 and Rd. 8522. The percentage stand of germination was apparently increased 20 per cent to 30 per cent by these seed dressings.

I wish to thank Imperial Chemical Industries, Ltd., through Dr. T. Callan for kindly supplying these preparations which have proved beneficial in the above experiments and are therefore worthy of further trial on a large scale.

C. A. THOROLD,
Acting Senior Plant Pathologist

B.—ANNUAL REPORT OF AGRICULTURAL OFFICER IN CHARGE OF GRASSLAND IMPROVEMENT

Apart from the period from the 1st January to the 15th March, and the latter half of December, I was absent from the country on overseas leave during the whole year. During this time the pasture experimental work at Kabete was supervised by the late Mr. T. K. Hill, Laboratory Student.

In July I attended the Fourth International Grassland Congress, which was held at Aberystwyth.

EXPERIMENTAL WORK

No new work was undertaken during the year. At the Kabete centre, routine work was continued in connexion with the experiments described in the report for 1935 and referred to in last year's report.

Preliminary trials of a number of pasture species were carried out, and progress made with the trials of species which have been recently acquired has led, in a few cases, to promising results.

In the search for pasture legumes to be used in mixture with the grasses for the areas of intermediate climatic conditions, experiments, referred to briefly in the reports for 1935 and 1936, have shown that *Lespedeza* spp. and *Trigonella foenum-graecum* have failed to survive in mixture with *Chloris gayana* (Rhodes grass) and *Bothriochloa insculpta*. The two most promising types for the purpose in view are still Lucerne and *Indigofera tettensis*. Further, it appears that a proportion of 5 lb. of Lucerne per acre results in a decided depression of the yield of a mixture of this plant with the Queensland strain of *Chloris gayana* and that the optimum amount to use is somewhere below this figure. Recent results in field trials of *Astragalus venosus*, an indigenous plant fairly widely distributed in high altitude areas, have given considerable promise and it is proposed to investigate the possibilities of this plant as a leguminous constituent of mixtures.

With regard to grasses, the most notable advance during the year has been in the case of a Giant *Cynodon* species received from Uganda in 1934. This grass, which can be readily established from seed or cuttings, has succeeded over a variety of climatic and soil conditions, but it is probably best suited to areas below 6,000 ft. The grass is palatable to stock and, judged by a severe cutting treatment to which it

has been subjected, is capable of withstanding moderately heavy grazing. It has shown a marked degree of drought resistance. As this type is strongly stoloniferous and rhizomatous and is capable of very rapid increase it may prove valuable in soil erosion control in native areas. Results on the tropical black earth type of soil, where exceptionally heavy yields of hay have been obtained, have been particularly promising.

In the study of the indigenous flora which has formed the basis of the work, certain grass types have emerged as the most useful for conditions in this country. These are almost without exception, the stoloniferous grasses, and outstanding amongst these are *Chloris*, *Cynodon* and *Pennisetum clandestinum*.

Within each of these groups there is great scope for the study of ecotypes. Changes of altitude, often fairly abrupt, result in the isolation of areas occupied by the same species in different parts of the country, and in these scattered ecological islands distinct types are to be found.

As the work progresses particular attention is being paid to these ecotypes. Six forms of *Chloris gayana* and three of *Pennisetum clandestinum* are already included in the experiments. With regard to *Cynodon*, reference has been made to a large type which has, as yet, received no species name. Apart from this, several types of *Cynodon dactylon* and a number of other *Cynodon* species of uncertain identity have been obtained.

It should further be mentioned that, during the year the progress of a preliminary experiment, one of the aims of which is to isolate the grasses which are capable of best withstanding frequent defoliation, has shown that under Kabete conditions the following are markedly successful in this respect: three strains of *Chloris gayana*, *Pennisetum clandestinum* and *Cenchrus ciliaris* (low-growing strain).

AIMS OF THE WORK

Agricultural development in Kenya is moving towards more intensive methods of farming wherever the rainfall is sufficient to permit of such methods. This process is slow in many parts of the country, but in others, particularly certain native areas, a rapid movement in this direction is, perforce, taking place. In these areas the pressure of increased population is leading to insufficient land for the older and more extensive methods of utilization.

Maintenance of soil fertility is the outstanding problem of this change and the most important factor in fertility is undoubtedly humus. This is probably true the world over, but under the climatic conditions of this country, attention to this factor appears to be of peculiar significance. In the Annual Report for 1934 (published in the East African Agricultural Journal, Vol. I, No. 4, January, 1936), it was shown that the key to pasture management in the high altitude areas lies in attention to the organic matter level of the soil, and that this is the determining factor, in these areas, between practically useless herbage and a superior pasture type.

The maintenance of fertility, and particularly of humus in the soil, demands the progress of mixed farming as against purely crop production for food and cash, for the grazing animal under intensive management is the most effective means of ensuring an adequate supply of humus. The farming system of the future, both European and native, must essentially be based upon crop rotation which provides for live stock. The grass ley of three or four years duration is preferable to permanent pasture for this purpose, both from the point of view of quality of pasture and maintenance of soil fertility.

One of the main requirements of this development is, then, the provision of grass and legume types which can be used as leys in rotation with arable crops, and this is the chief aim of the experimental work at Kabete, which deals with the high altitude and intermediate areas of the country.

The extending use of Rhodes grass, which makes an excellent ley, and which can be used over a wide range of conditions, is one of the results of this work which has already been dealt with in previous reports. This species is successful over large areas of the country lying between 4,000 and 8,000 ft. altitude. Work in progress on the various strains of *C. gayana* may produce more valuable types than the one at present in use. The Giant *Cynodon* referred to above is likely to prove particularly useful in some of the lower-lying native areas, and, even in the high altitude moist areas, experience is showing that arable land allowed to revert or planted to Kikuyu grass may be successfully used as a temporary ley. In certain other areas rapid natural reversion to useful pasture types also takes place.

Reference has also been made to the attempt to produce legumes for use in mixture with the grasses. Apart from the Kikuyu grass areas, where a proportion of *Trifolium Johnstonii* usually exists naturally under conditions of close grazing, this problem has progressed little towards solution.

The thinly populated, extensive dry areas of Kenya present a different problem. Here the possibilities of development are strictly limited and progress must be based upon methods of control of grazing on extensive lines, in order to prevent deterioration of the herbage. With this end in view, a considerable amount of survey has been undertaken and, recently, an experiment in grazing control on a 300 square mile area has been started on the Yatta Plain.

LECTURES, ADDRESSES, ETC.

On my return from leave on the 12th of December, a series of addresses was given at farmers' days held at Nanyuki, Thomson's Falls, Londiani and Moiben, from the 15th to the 22nd December.

HERBARIUM

A collection of plants was submitted to the Royal Botanic Gardens, Kew, in the early part of the year, and it is desired to acknowledge the valuable assistance given in the identification of pasture species.

PUBLICATIONS

(1) A review of the Grassland Annual Report for 1935 was published in *Herbage Reviews*, Vol. 5, No. 2, June, 1937.

(2) A paper on "Three ecotypes of *Pennisetum clandestinum* Hochst (Kikuyu grass)", appeared in the *Empire Journal of Experimental Agriculture*, Vol. 5, No. 20, October, 1937.

D. C. EDWARDS,

*Agricultural Officer in Charge of
Grassland Improvement*

PART VII—ANNUAL REPORT OF THE PLANT BREEDER

STAFF

Mr. R. J. Lathbury, Plant Breeder.

Mr. R. S. Ball, Agricultural Officer.

Mr. R. N. Noble, Junior Laboratory Assistant.

Mr. H. Moraes, Goan Clerk.

All officers were on duty at Njoro for the whole of the year with the exception of Mr. Noble who was absent for two months due to illness.

The services of one plant breeder only were again available for the year under review, the Senior Plant Breeder and Experimentalist having been transferred to take charge of the Coffee Team.

All meetings of the Wheat Advisory Board were attended.

The Plant Breeder was in general charge and supervision of the field experimental work in the Rift Valley Province.

WHEAT—GENERAL

A very fair season was experienced, though the continuous rain from April to August hindered the preparation of the land in some cases and on the other hand caused disease in the early sown wheat. No increase in acreage is to be recorded and the yield is estimated at three and a half bags per acre. The percentage of first grade wheat is high. Owing to the increased local consumption of flour and the damage done to the young wheat crop in certain districts by army worm it was considered advisable to import 5,000 bags of wheat to prevent the risk of any milling shortage before the new crop was available.

3,000 bags of wheat No. 58 were issued to the medium and lower altitudes and this wheat generally gave satisfaction. Unfortunately its issue coincided with the appearance of a further form of stem rust to which it was susceptible, but this new form where present was only severe in a few cases. Wheat No. 58 is of course resistant to the remaining four forms of stem rust and is therefore still likely to be of value.

Sabanero again maintained its rust resistance in the field and represented 15 per cent of the crop. The balance mainly consisted of wheats Nos. 500, 503, Kenya Governor, Burbank, Equator and B. 256.G.

Stem Rust

It will be recollected that mention was made in the 1936 report of a new physiologic form of stem rust of which one pustule only was discovered, which was thought to be a mutation arising from Form K4. In February, 1937, rust was found on volunteer 58.F.(L.I.) and Sabanero. Investigations on this rust were made at Njoro and at Kabete and it was found that a new physiologic form was present to which wheat No. 58 was susceptible and that this wheat was therefore itself a differential to this new form. Subsequent inoculation studies showed that the reactions obtained were those of Form K4, though these reactions were not always constant. Furthermore, on several occasions Form K2 reactions were also found in addition to Form K4 and it would therefore appear possible that the apparent impurity of this new form may be due to the presence of two and not one new form.

The rust arising from the single pustule in 1936 also showed a K4 reaction and it is likely that this form is in fact the same as the 1937 form, but in view of the varying reactions obtained this year which show in addition intermittent K2 reactions, it has been found necessary to lay down further experiments to clear this matter up and results are not yet to hand.

Subsequently this new form (K5) appeared fairly generally throughout the country, though the damage caused by it was only severe in a few cases and there are indications that epidemics of this particular form may not be quite so virulent as in the case of Form K4.

Rust studies in co-operation with farmers were again carried out and these in conjunction with specimens sent to the Scott Agricultural Laboratories for identification revealed the distribution of forms to be as follows:—

Physiologic Form of Stem Rust	Number of Centres at which found
K. 1	3
K. 2	14
K. 3	2
K. 4	7
K. 5	10

Form K2 besides being most prevalent did most damage. As in the past the different forms could not be associated with specific areas or conditions, though Form K4 is diminishing in the absence of suitable host varieties, whilst K1 is just beginning to appear again after a lapse of some years.

On the whole damage by rust was not great. K2 was the cause of severe damage in some crops, especially at the lower altitudes, but appeared too late in most cases at the higher altitudes to effect yields to any extent. K5 whilst present early on, for the most part did not spread to the extent which might have been expected.

The absence of the Senior Plant Pathologist on leave and his subsequent transfer prevented any work being done on the identification of the new form of stem rust, though routine inoculations were carried out at the Scott Agricultural Laboratories as usual.

An artificial infection of stem rust embracing all four forms was again successfully created at Njoro. At Kabete little natural rust was present and the artificial infection failed to spread satisfactorily. Rust blocks, each embodying a single form of stem rust well separated from each other, were again laid down at Njoro and proved of value in testing out the resistance of fixed lines to the various forms of stem rust. One such block embodied the new Form K5.

Diseases and Pests

The incidence of leaf rust was moderate. Yellow rust, whilst severe at the highest altitudes as was to be expected, generally caused little damage and susceptible varieties such as No. 58 escaped injury when grown well over the 7,000-foot level.

Black chaff was very severe in the early sown wheat that experienced wet growing conditions, and wet weather at the time of flowering in particular would appear to be associated with severity of attack. It was very noticeable that the later sown crops which missed these wet conditions during the flowering and ripening period showed a slight infection only, and a difference of as little as ten days between sowing often meant the difference between a badly and slightly infected crop. In severe cases the yield was reduced to two or three bags of shrivelled grain. No variety appeared entirely resistant, but there were marked degrees of susceptibility between varieties, Sabanero being much better in this respect than No. 58.

As advocated last year a number of "Take-all" infected fields at the higher altitudes are being planted to pyrethrum. Growers however must still keep a sharp look out for the presence of this disease and whenever possible continuous cropping of wheat should be avoided.

An invasion of army worm at the lower altitudes caused some damage amongst young wheat and two thousand acres were replanted.

Wheat Breeding at the Plant Breeding Station, Njoro

The important factor in the breeding work has been the appearance of a fifth form of stem rust. It will be recollected that the original Njoro wheats showed resistance to Forms K3 and K4 of stem rust as and when they appeared in the country. In the case of K5 tests to date reveal that these wheats in conjunction with most of the present varieties show a varying amount of susceptibility to this new form, though in most cases the susceptibility is a moderate rather than a full one. Certain wheats, however, are markedly resistant and amongst these are Reliance and DC. 2303. Fortunately these two wheats have been embodied in crosses made in 1935 and subsequent years and these crosses therefore become of prime importance. In each year the F_1 generation from the cross has been grown at Kabete over the short rains, but it is not practical to continue growing two generations a year as rust epidemics at Kabete over the short rain season are rarely severe enough to allow of selection work being performed. Once the rust resistance of the selected plants become fixed two seasons a year can again be utilized in their multiplication.

In addition, there are two hybrid wheats which show definite resistance to this new form and in fact to all five forms. One of these is a strain out of cross No. 117 (Marquis x Njoro wheat) seed of which is in the hands of two growers. Preliminary baking trials indicate a lack of balance and if the present season's crop shows no improvement in this respect it may be necessary to discard this strain. The second wheat is a single plant selection out of a hybrid and a few ounces of grain only are available. Further crosses were also made at the same time with this No. 117 wheat. The complete list is as follows:

Crosses made in 1935.

- No. 223—DC.2303 x 112.E.8.L.5.
- No. 289—DC.2303 x 130.A.7.B.
- No. 235—131.C.13.A.2. x DC.2303.

Crosses made in 1936.

- No. 261—68.E.12.A.1. x Reliance.
- No. 267—112.E.8.L.5. x Reliance.
- No. 279—Reliance x 130.A.5.E.5.
- No. 280—Reliance x 112.B.11.(L.1)2.

No. 284—Aust. 26.A. x 68.E.12.A.1.

No. 285—Aust. 26.A. x 130.A.5.E.5.

No. 287—Aust. 16.A. x 130.A.5.E.5.

No. 288—Aust. 16.A. x 68.E.12.A.1.

Crosses made in 1937.

Australian 26.A. x Reliance.

Australian 26.A. x 117.A?

Australian 26.A. x DC. x Ceres 721.

Australian 26.A. x 130.A.1.G.9.

Australian 26.A. x DC. 2303.

Australian 32.F. x DC. x Ceres 721.

Australian 32.F. x Reliance.

Australian 32.F. x 130.A.5.E.5.

Australian 32.F. x 130.A.1.H.2.

Australian 32.F. x Hope x Reward 1162.

117.A.? x 130.A.5.E.5.

Some double crosses were made between the 1936 crosses and a large number have been made between the 1937 crosses. Apart from general stem rust resistance the 130 strains are in particular included for their resistance to yellow rust, the Australian/Kenya hybrids for their resistance to leaf rust and straw strength, and Reliance and DC. 2303 for their resistance to the new form of stem rust and for their baking quality.

Further crosses have also been made between Simpson's and Douglas's selections with Reliance and DC. 2303.

Cross No. 172—Njoro Hybrid x Reliance.

This cross is now in the fifth generation and plants combining resistance to leaf and stem rust have been obtained. Most cultures however suffer from weak straw and slow maturity and may have to be discarded on this account.

Crosses Nos. 202 and 203—(112.E.8.L.5 x Kabete Hybrid).

These two crosses were grown at the Molo cage and cultures resistant to yellow rust were harvested. The best of these will be continued with at Njoro, but in view of the susceptibility of both parents to Form K5 of stem rust their future value is problematical.

Several further crosses in the F₃ generation, a generation behind the above, may also have to be discarded as none of the parents are resistant to Form K5. In other respects, however, they are promising.

Cross No. 130—(Njoro hybrid x Australian Florence selections).

A few bags of one strain were harvested and this wheat would appear to show slight resistance both to forms K2 and K5. Preliminary reports on its baking quality are very promising. Nearly 1,000 bags of another strain were reaped and it is hoped that this wheat will be an improvement on the 500 strains as whilst it possesses some susceptibility to Form K2 and K5 it is both a better yielder and more resistant to leaf rust than the 500 wheats. One high altitude grower reaped 9 bags per acre over 70 acres as against 7 bags per acre of No. 500 which was growing adjacent to it, and the former bushelled 62 lb. against the 59 lb. of the latter. The grain colour of both these two wheats is white. Several further strains which have shown marked resistance to yellow rust are also being tested out by high altitude growers and have given satisfactory yields.

Crosses Nos. 117 and 122—(Njoro hybrids x Marquis).

Two strains have been grown, No. 117.1.5.F. and 122. D.I.T. Both are susceptible to Form K2 of stem rust and susceptible to leaf rust, but are worth a further trial where they have proved satisfactory in view of their good baking qualities.

Cross No. 112—(English hybrid x Njoro hybrid).

Three strains have been kept on No. 500, 503 and a white grained strain No. 112.E.8.L.5. All are susceptible to Form K2 of stem rust and to leaf rust. They have been generally grown at the high altitudes and on good land and where they have escaped rust they have yielded well. In view of their marked susceptibility to leaf rust it is hoped that they may be replaced by strains out of cross No. 130.

Cross No. 58—(Red Egyptian x Kabete hybrid).

Ten thousand acres were sown to this variety. Some of the early sown wheat suffered badly from black chaff, but on the whole good crops were harvested and it is most unfortunate that it should have proved susceptible to the new form of stem rust which did not however cause much damage. It is still likely to prove a valuable wheat in the future.

Wheat No. DC x Ceres 721.

This wheat, a Canadian production, was grown at several centres and promises well. Stem rust was in no case severe

and trials of this wheat will be extended this coming season. Single plant selections which show increased rust resistance have also been made.

Crosses Nos. 142 and 179 have been discarded.

Australian-Kenya Hybrids.

The best of these crosses were again grown for observation and multiplication. Most of them showed some susceptibility to the new form of stem rust as did the Kenya parents, and they may not therefore prove of direct use, but they have been utilized in crosses both this year and last. Sown early they were badly attacked by black chaff, but maintained their leaf rust resistance. One strain, Kenya Standard x Baringa x Nabawax Wandilla, in view of its earliness, very strong straw and resistance to leaf rust, is being multiplied.

Yield Trials

A randomised block yield trial comprising thirty-three varieties replicated six times was sown at Njoro. Severe damage by black chaff largely nullified results. Good results were, however, obtained at Molo where a series of eighteen wheats replicated seven times was sown in the middle of a large field of wheat through the courtesy of Captain C. T. Soames. By this method the usual damage by birds to the outside edges of the plots and in some seasons to the whole area of the plots was entirely avoided.

A small variety trial was also carried out on the Rongai plots.

Wheat Breeding at the Scott Agricultural Laboratories

The wheat crosses grown at Rongai the previous year were transferred to this centre and comprised crosses between wheat No. 58 and one of the 117 strains with the Kabete wheats. White grained selections resistant to stem rust and possessing better baking quality than No. 58 were obtained. In view of the susceptibility of all these parents to Form K5 of stem rust only a very few of the best selections will be carried on and these will be crossed with the object of adding resistance to K5 in the same way that resistance to K4 has been added. This centre is also utilized to grow on any F_1 generations and multiply wheats over the short rain season.

Thanks are due to Mr. E. C. M. Green, the Assistant Agricultural Officer at the Scott Agricultural Laboratories, for his assistance in this work.

Molo Sub-station

As usual further yellow rust tests were carried out at this station. The F_3 progeny of two crosses were also grown and yellow rust resistant selections made.

Analyses of Baking Quality

Further samples were again sent to Dr. Kent Jones through the courtesy of Messrs. Unga, Limited. In addition a number of Pelshenke tests on pure line hybrids were made by Mr. Noble. Contrary to expectation one of the yeast preparations on the market "Florylin" gave very fair results.

Extra Territorial Trials

Samples of some of the new hybrid wheats have been sent to Uganda, Tanganyika Territory, the two Rhodesias, Nyasaland and South Africa for trial.

OATS

Further imported varieties from India and South Africa grown at Njoro and Molo all proved susceptible to stem rust and very susceptible to crown rust.

The Australian variety Lampton has maintained its stem rust resistance this year. It has also shown resistance to smut in this country and has met with approval from growers. A yield trial at Molo was vitiated due to damage by birds.

Some Victoria x Richland x Belar hybrids received from Australia all proved susceptible to stem rust, but Algerian x Lampton strains showed resistance and these will be grown on.

BARLEY

Most of the commercial varieties grown in the country are losing their purity and the Department have therefore imported fresh stocks. Chevalier barley, both the early maturing type and the true later maturing type suit these conditions better than the Archer barleys and a bag of the former called Prior has been imported from Australia as well as a very small supply, all that was available, of the true type from the National Institute of Agricultural Botany, Cambridge. In addition a sample of a new variety of Golden Archer bred by Dr. Beaven has also been imported for trial and comparison.

MAIZE BREEDING

This work was again carried on at Kitale and Njoro. Selfed lines at both centres have now reached some degree of purity and a large number of single and double crosses

have been grown. Results of crosses showed that no significant increase in yield over the mass selected control seed had been obtained, though some of the crosses yielded as well as the control. This lack of improvement in yield can be attributed firstly to the small number of disease resistant lines originally available which limited both the number of possible combinations which could be obtained and the chances of increased heterosis, and secondly to the fact that the Kenya flat white type of maize is already very cross-bred compared with the type in use in America and South Africa, which would again tend to limit the effects of heterosis. With a view to adding to the number of unrelated lines exchanges of material comprising selected lines and single crosses were made between Njoro and Kitale and a large number of single and double crosses made and it is hoped that some of these crosses may give increased yields.

Marked resistance to white blight (*Helminthosporium turcicum*) was obtained at Kitale and two synthetic varieties comprising a number of the most resistant lines bulked together will be grown on.

At Njoro, 51 selfed lines were sown as well as a number of single and double crosses. Further crosses were made including single and double crosses between Njoro and Kitale strains. In all over 500 selfed or crossed cobs were harvested. Mr. R. N. Noble carried out the crossing work at Njoro and Mr. M. Halcrow was responsible for the maize breeding work at Kitale under my direction.

The latter reports as follows:—

“During 1937 conditions were extremely suitable for a high incidence of white blight (*Helminthosporium turcicum*) and it is gratifying to record that the selected resistant strains showed almost complete freedom from infection whereas unselected maize growing alongside had nearly one hundred per cent of plants diseased. Of 143 double crossed resistant strains that were under test for yield, only 12 appeared as heavy yielding as the general seed, and of these none were outstanding. This result is not so disappointing as it appears since it is obvious that an increased number of unrelated parents is required to ensure greater heterosis in the crossed strains. Pure lines have been imported from Njoro and with the use of younger Kitale lines it is almost certain that this work will be more fruitful in the near future.

It has not been possible to record any progress in regard to resistance to Pink Ear rot by the present methods of selection.

During the year, 1,285 pollinations were made. In addition to the continuation in 1938 of the selected pure lines and crosses material has been kept with a view to making two synthetic lines for resistance to white blight."

PYRETHRUM

With the establishment of the selected material at the 8,000 feet level at Njoro it was possible to weigh pickings made from individual lines. At the same time the Chemical Section helped by making analyses of the pyrethrin content of the more promising lines. Twenty-two lines were analysed and there was a big variation between lines, the highest pyrethrin content having a figure of 1.78 per cent and the lowest a figure of 1.01 per cent. The control figure was 1.46 per cent and only seven plants approached or exceeded this figure, the majority being disappointingly low. The best are given below:—

LINE	Pyrethrin Content Per cent Calculated to Dry Weight	Mean Weight of Dried Flower Head Mgm.	Order of Yield of 26 Lines
	<i>Per cent</i>	<i>Mgm.</i>	
24 ..	1.78	200	18
14 ..	1.75	221	11
25 ..	1.58	216	—
31 ..	1.57	203	14
36 ..	1.56	178	13
22 ..	1.41	154	6
35 ..	1.40	258	2
Control ..	1.46	168	21

In addition one other line of which there was not enough material for a yield test was outstanding in possessing a very large head weighing 330 mgm., and whilst its pyrethrin content was only 1.30 per cent, yet it is felt that this large size of head coupled with an upright growth and prolific appearance should make this line No. 20 of value.

At the suggestion of the Senior Agricultural Chemist an experiment was laid down to try the effect of growth promoting substances in producing parthenogenesis so that in this way the self sterility of the pyrethrum flower could be overcome.

Hortomone A was the growth promoting substance tried and covered plants were sprayed with weak dilutions of this solution. Four dilutions were used, namely 1:100, 1:250, 1:500 and 1:1,000 and four sprayings with each were made at weekly intervals.

Germination tests were subsequently made, but none of the seed proved to be viable.

The preliminary crosses have produced nothing of value and only one or two of the recent crosses have given viable seed. Further crosses between line 20 and some of the high pyrethrin content lines are being made. Four plants of each of the two lines embracing the cross are being planted together in situations isolated from other pyrethrum to avoid covering of the plants in the hope that an increased number of plants growing in the open may give better results.

In a plant of such mixed genetic constitution as pyrethrum incompatibility is not likely to be of importance in the field where the population consists of thousands of plants, but it may account for the poor results obtained from the crosses where two plants only are involved.

Once however compatibility is obtained between pairs of selected lines it should not be difficult to build up a plantation consisting of alternate rows of desirable clones.

R. J. LATHBURY,
Plant Breeder.

PART VIII—CHEMICAL SECTION

ANNUAL REPORT OF THE SENIOR AGRICULTURAL CHEMIST

STAFF

During the past year there have been several staff changes. Mr. G. H. Gethin Jones, Soil Chemist, was seconded to the Coffee Team. Mr. L. Burton, Junior Laboratory Assistant, resigned with effect from 11th June, and Mr. C. T. Dewar was appointed to the vacancy on 6th August. Mr. R. H. Pullen-Burry was appointed under a grant from the Sisal Industry Committee as Assistant for Sisal Flume Tow Retting Investigations.

The detachment of a senior officer from the staff of the Chemical Section has considerably reduced its elasticity. With two senior officers available it was possible so to allocate minor problems arising as to cause the minimum of disturbance to major problems. Under the present staff arrangements all such work now falls upon one man, and often items of work which should be continued have to be suspended owing to the demand of more important, or rather more insistent, *ad hoc* problems. Possibly it was visualized that the writer would be completely relieved of all work in conjunction with coffee. In reality, in view of his long association with coffee and its associated problems, the writer has very frequently been called into consultation by members of the Coffee Team, which consultations have occupied a good deal of time.

PYRETHRUM

The establishment of the guarantee of a minimum pyrethrin content for pyrethrum flowers for export has led to a great increase in work, since large numbers of the necessary regulatory analyses have had to be made. In view of the importance of this work at least one member of the staff has been completely detached to undertake it, but it is manifestly impossible for the section as constituted to continue the work.

In response to representations the Pyrethrum Board has offered to pay Government annually a generous contribution towards the salary of an officer to undertake these regulatory analyses and such research work as may fall within his province. This appointment will be made at the beginning of

1938. The method of analysis employed by us has given rise to a good deal of correspondence from some people who have little or no knowledge of either chemistry or the conditions in Kenya. The method that we employ is one that has been forced upon us by local conditions. The result of the collaborative work between Dr. Gnadinger and the writer has been a marked increase in the price of Kenya flowers, which are generally regarded as occupying the premier position.

The writer has attended in an advisory capacity several meetings of the Pyrethrum Board, mainly in connexion with the subject of grading and the maintenance of quality. In collaboration with the Board's new specifications, four grades have been drawn up, which resulted early in a marked improvement in the general average quality. In this connexion an article was published in the local Press on the subject, reprints of which were distributed by the Kenya Farmers' Association to all pyrethrum growers.

SISAL

Since the inception of the research work on sisal the writer has attended all the meetings of the Sisal Industry Committee, not only in order to report progress of research work but in an advisory capacity. The development of the research work has led to the establishment of the Joint Standing Committee for Sisal Research elected from members of the Sisal Industry Committee, the Sisal Growers' Association, and the Department of Agriculture. Mr. Pullen-Burry and the writer are both members of this Committee.

It has been decided to establish the High Level Sisal Experiment Station, and the research committee have drawn up full plans for both agronomic and non-agronomic work. Since it appears that the non-agronomic research will give results of importance and economic in its effects, it has been agreed that, for the first two years at least, work will be concentrated upon certain problems of fibre production. The agronomic side has not been forgotten, but it appears desirable to wait until the land of the proposed sisal research station has been worked for a couple of seasons and brought to an even condition before laying down experimental plots. In the meantime, work on the non-agronomic side will be conducted at the station, when established, and close touch maintained with the Tanganyika Sisal Research Station at Ngomeni.

After examining several pieces of land it was decided that application be made for two farms on the west side of the Fort Hall Road in the Thika district. As soon as this land has been allocated us, work will be commenced both in the preparation of the land for agronomic experiments and on non-agronomic experiments. Full estimates of the capital cost for establishing this station and the annual cost for maintenance were drawn up by the Research Committee and submitted to the Sisal Industry Committee.

GENERAL SECTION

The writer as a member of the Pollution Committee of the Water Board has attended the various meetings and has served in a consultative capacity to the two members of the Committee who are undertaking the active work.

An exhibit was shown at the Nairobi Show demonstrating the latest work of the section on sisal and pyrethrum, the need for soil conservation measures in pyrethrum plantations and certain faults in the making of composts. This exhibit aroused a great deal of interest.

Two wireless talks, the subjects being "Some Aspects of Soil Erosion" and "Composting", were given during the year, and several articles were published on agricultural subjects in the *East African Agricultural Journal* and the local Press.

In the course of their duties members of the section travelled a total of 4,600 miles.

INVESTIGATIONAL WORK DONE

The number of samples taken and received this year remains about the same, although all samples referring solely to coffee problems are not recorded here. The character of the samples is given in tabular form:—

NATURE OF SAMPLE	Pending 31-12-36	Received	Exam- ined	Refused	Pending 31-12-37	Total
Soils.. ..	—	65	65	—	—	65
Fertilizers ..	—	27	25	2	—	27
Waters ..	—	10	10	—	—	10
Pyrethrum ..	2	126	115	2	11	128
Tobacco ..	—	50	43	—	7	50
Sisal.. ..	—	193	193	—	—	193
Essential Oils	—	14	14	—	—	14
Miscellaneous	—	21	21	—	—	21
	2	506	486	4	18	508

SOILS

It has not been possible to do any soil survey this year; the majority of the samples are samples brought in by farmers in conjunction with advisory work.

A laboratory investigation was conducted into the rates of decomposition and nitrification of a leguminous green manure and heavy weed growth, in the course of which certain observations were made, which are of such importance that they will be followed up as soon as the staffing of the section becomes normal. In these experiments lucerne was used as the type green manure and well-grown pigweed (*Amaranthus graecizans*), which was very common at the Scott Agricultural Laboratories, as the type weed. Quantities of the finely ground material, corresponding to very heavy growths of the crop, were added to soil which was incubated, in definite quantities, for varying periods. The preliminary determination of nitrate nitrogen in the fresh mixture showed that the weed-soil mixture contained twice as much nitrate nitrogen as the legume-soil mixture, a most unexpected observation, which will be discussed below. The total nitrogen was about the same in the two mixtures.

The rate of decomposition in both mixtures was almost identical; at the end of one period the weed would show more decomposition, at the end of the next the green manure. The nitrification picture was very different. Nitrification in the legume mixture proceeded smoothly and rapidly, and in the early stages there were quantities of ammoniacal nitrogen produced, a typical example of nitrification. Although the weed mixture had so large a start in nitrate nitrogen, the quantity of available nitrogen remained stationary for nearly four weeks; nitrate nitrogen increased slightly while the ammoniacal nitrogen dropped. Right through the course of the experiment, twelve weeks, the amount of available nitrogen in the weed-soil mixture was much less than that in the legume-soil mixture.

More work is needed on this subject, which will be followed up as soon as staff permits, but it does appear that mere nitrogen content of a green manure does not decide the rate of nitrification; there are other factors. A leguminous green manure crop, too, very quickly supplies large quantities of available nitrogen which, if rainfall be heavy, may be washed beyond the feeding zone of the roots. Although the proportion of nitrogen in weeds of this type may be as great

as in the legume, the formation of available nitrogen is slower and so such a green manure affects the supply of available nitrogen over a longer period.

The most unexpected observation, that the weed-soil mixture was so rich in nitrate nitrogen, was found to be due to the fact that pigweed contains large quantities of nitrate nitrogen; more than a hundred times the content of a rich soil. Experiments done this year, which too will be continued, show that, right through its life, pigweed contains quantities of nitrate nitrogen. It is a matter of common knowledge that pigweed and other species of *Amaranthus* are very common weeds on old hut and *boma* sites. This distribution is generally regarded as being due solely to the concentration at such sites of dung-borne seeds. On the contrary, the presence of a heavy growth of pigweed must be taken as indicating that the land has a high nitrogen fertility. In one way, too, pigweed must be considered to be a beneficial weed; it stores up quantities of nitrates which would otherwise be leached away.

FERTILIZERS

Several of these samples were submitted for commercial analysis, one of the most interesting being shea nut cake, the residue left after the extraction of shea butter. On account of the astringency of the cake it is impossible to use it as a stock feed, so an opening for its use as a manure is being sought.

As mentioned in my last report, most of the compost samples examined still contain too much soil as an adulterant.

WATERS

Most of the samples of water were submitted for examination for their suitability for irrigation or stock watering. A simple rapid technique has been evolved which permits of their examination in a few minutes.

Two samples were fully analysed on behalf of the Game Department; one from Lake Naivasha shows a great reduction in soda content as a result of dilution. A sample from the Crater Lake near Lake Naivasha has a soda concentration of over tenth normal and a pH over 11, beyond the range of our instruments.

PYRETHRUM

The possibility of the sale of Kenya pyrethrum flowers on the basis of a minimum pyrethrin content of 1.30 per cent, mentioned in my report last year, became an established

practice in 1937 and resulted immediately in an enhanced premium for Kenya pyrethrum of about 45 per cent over Japanese. Samples are drawn, at the time of baling, from a well mixed lot of pyrethrum; these are combined and a sample, representative of 25 tons, 125 bales, drawn for analysis, upon the results of which is based the guarantee. At the same time, the collaborative work with Dr. Gnadinger was continued, substantiating the basis of the guarantee. The average reduction in moisture content during transit was 1.4 per cent, and the loss in pyrethrins 6.5 per cent of the average pyrethrin content, calculated on the dry basis. A joint paper, giving the details of this collaborative work, which led to the establishment of the guarantee, has been prepared for publication in an American scientific journal.

In these analyses the method employed is the copper reduction method of Gnadinger. The adoption of this method as standard in Kenya has been strongly criticized by interested parties. These criticisms, which in some instances have been most strongly worded, especially when offered by those lacking chemical knowledge, should disappear if the conditions here are fully appreciated. Incidentally, the Gnadinger copper reduction method is official in the other two pyrethrum producing countries of importance, Japan and Dalmatia.

Although the description of the Ainabkoi drier appeared in the *East African Agricultural Journal* for January, the work on a drier was not completed. Several driers were built on the lines described, but modifications were introduced and difficulties encountered, some rather inexplicable. Therefore a further careful study was made by Mr. R. O. Barnes of the Pyrethrum Board and Mr. F. McNaughtan of this section. It was ascertained that the building design could not be improved upon but that a different flue system would give more even heating. A new flue system was designed, which gave greater turbulence to the smoke stream, and detailed plans were drawn by Mr. Barnes. Blue prints have been prepared by the K.F.A. for sale at a nominal fee. This drier is most efficient.

As a result of the growing change-over to the Ainabkoi drier the appearance of Kenya flowers has improved and are now more attractive than another on the market. Although appearance no longer carries the weight it used, it does indicate care in preparation. Most favourable remarks regarding

the appearance and the evident care in preparation of Kenya flowers have appeared in overseas journals in which pyrethrum matters are discussed.

About the middle of the year there was a marked drop in the pyrethrin content of the general average of flowers. Advantage was taken of this to tighten up the grading. Very many of the consignments arriving at Nakuru contained large proportions of immature flowers. New grades have been instituted, the effect of which was very soon apparent.

The immaturity of the flowers alone was not responsible for the drop in pyrethrin content. With the decrease in the rains an increase in pyrethrin content to normal was at once apparent. One must conclude that, during periods of heavy and long-continued rain, there is a drop in pyrethrin content. This subject is being investigated further.

Among the hypotheses advanced to account for the drop in pyrethrin content was the advancing age of the general pyrethrum population. Jary (Jour., S.E. Agric. Coll., Wye, 1936; 38, 59) observed a very rapid drop in the pyrethrin content of the flowers from ageing pyrethrum plants. The first harvest had a content of 1.84 per cent, the sixth harvest contained 0.87 per cent only. Two long-period experiments, involving seedling and subdivided plants respectively, had been laid down at the Scott Agricultural Laboratories, but in order to prove the hypothesis quickly, samples have been obtained from fields of various ages from different districts and are in course of analysis. The results so far do not show any loss in pyrethrin content, so it can be accepted, until the results of the critical experiment are available, that pyrethrum in Kenya suffers no appreciable loss in pyrethrin content with age, whether the plants be seedling plants or are subdivisions of older plants.

TOBACCO

The work foreshadowed in my previous report on tobacco was started. In order to facilitate the selection of a strain of uniformly high nicotine tobacco, a small plot was planted at the Scott Agricultural Laboratories. Unfortunately, the growth was very poor and in some cases hardly enough leaf was obtained to permit of analysis. The leaves were so varied in age, too, that the product had a very low nicotine content. Arrangements have been made for tobacco from seed of the best plant in the Scott Agricultural Laboratories plots to be grown at Njoro for selling and selection, while the analyses will be made here.

SISAL

At the request of the sisal industry, who provided for the services of an assistant, the subject of the retting of sisal flume tow was investigated. The cause of the failure of previous investigations was early ascertained, and in a very short while flume tow was most successfully retted by normal methods. Unfortunately, these methods are uneconomic.

Further research led to the evolution of a new technique, which will not be described here, as at present it is desired to keep the details confidential to the East African sisal industry. The successful evolution of this new technique is very largely due to the enthusiasm and close application of Mr. Pullen-Burry, who made several hundred chemical determinations, in addition to the samples examined in the laboratory, during the course of the investigation. The retted flume tow is much softer and more pliable than normal, and will be suitable for spinning fine lines and for weaving fabrics. The thanks of the Department and of the industry as a whole are due to Messrs. Sisal Products (E.A.) Ltd., who placed many facilities at our disposal and thus assisted the investigation most considerably.

So interesting have been the results that a very much enlarged programme of work has been drawn up, which, if successful, will have very far-reaching effects on the sisal industry.

Although the problem was primarily chemico-microbial in its character, force of circumstances drove us to wander into the field of engineering. A washing machine has been evolved to deal with the retted fibre; the same machine, possibly, may be suitable for the collection of the flume waste tow.

Attention has also been directed towards the more complete utilization of the sisal plant; one or two new promising products have been isolated.

Throughout this work close contact has been maintained with the Linen Industry Research Association's Research Institute at Lambeg.

ESSENTIAL OILS

The lavender fields this year have reached the stage of production. The variety of lavender most suitable to Kenya conditions is an English strain and the oil is English in character rather than French. Although English lavender oil

commands so high a price, a similar oil produced elsewhere has to compete on an equal basis with French lavender oil. At first it appeared that there would be very little call for the Kenya oil, but a demand has now developed, which will absorb the whole of the present production.

MISCELLANEOUS

One of the interesting minor investigations during the year was done at the request of the Kenya Co-operative Creameries Ltd. Complaints were being received that the Creamery butter was much softer than normal farm butter, so the writer was requested to make a test. Four samples of butter were obtained—two farm butters and two Creamery. A simple penetrometer showed that at 15° C. and 20° C. the Creamery butter was firmer than the farm butter, while at 25° C. the farm butter had so softened that it could not be handled. From a superficial examination the main factor in this difference in hardness appeared to be due to poor texture and a big water content in the farm butter.

A certain amount of interest was taken in ramie fibre, but no simple way of producing the fibre was discovered. A method of facilitating the removal of the bark was evolved, but the cuticle still adhered strongly to the fibre. Retting was also tried on both decorticated bark strips and on the whole stems. While this made it possible to remove the trash the fibre tended to break down into its constituent short fibrils, giving a soft tow.

There is no doubt that the spectograph will become a most valuable tool in the equipment of a chemical laboratory, but it requires very careful study before it can be used in general work. There are many difficulties to be overcome. The study we have made in these laboratories of its possibilities, during which some ten thousand measurements have been made, have unfortunately had to be suspended. On account of staff re-arrangements and the demands of new *ad hoc* investigations, it has been impossible to continue the work this year. During the coming year, it may be possible to solve some of the problems affecting its use, one of the most difficult of which is connected with the variation in the sensitivity of different parts of a photographic plate, variations of no importance in ordinary critical photography, but which affect the sensitive photometer employed very markedly.

PART IX—ENTOMOLOGICAL SECTION

ANNUAL REPORT

STAFF

Mr. A. R. Melville, Entomologist, and Messrs. H. Naismith Jones, E. Cottington, and C. D. Knight, Plant Inspectors, were transferred to the Coffee Services as from the 1st January. Dr. R. H. Le Pelley, Entomologist, returned to the Colony on 10th September, 1937, after an absence of more than three years. On his return Dr. Le Pelley was seconded to the Coffee Services. Only one Entomologist and one Plant Inspector, Mr. Fox, now remain in the Entomological Section.

As previously reported, correspondence, routine work, interviews, identification of specimens, meetings and general advisory work are increasing to such an extent as to occupy the whole time of the Entomologist in charge.

Under these conditions and with the transference of five members of the Entomological staff to the Coffee Services, the maintenance of continuity and the undertaking of serious research work in the Entomological Section would appear to be a matter of great difficulty.

LEGISLATION

In accordance with the recommendations of the conference on the co-ordination of research and plant protection held at Amani in February, 1934, with a view to the adoption of similar regulations in the East African territories, the Diseases of Plants Prevention Ordinance and Rules have been re-drafted, and a new Ordinance, cited as the Plant Protection Ordinance, 1937, was assented to on the 28th day of August, 1937. This Ordinance was drafted to make better provision for the prevention of the introduction and spread of disease destructive to plants. Under the new Ordinance orders and two schedules of plant diseases and insect pests were promulgated on the 2nd September, 1937. Apart from an attempt at unification of regulations in

the East African territories, the chief differences in the new Ordinance are:—

- (1) It is now necessary to apply for a permit to import any plant or part of a plant, but not seeds, except those listed in the schedule.
- (2) General powers previously invested in the Director of Agriculture are now vested in His Excellency the Governor.
- (3) The diseases and pests appearing in the Schedules drawn up are notifiable.

COFFEE MEALY BUG

Due to the work of Dr. Le Pelley and the further knowledge obtained in respect of the two mealy bugs, *Pseudococcus lilacinus* and *Pseudococcus kenya*, it is concluded that these two mealy bugs are not so closely related as was previously thought; difference between them has also been demonstrated in practice by the fact that *P. kenya* proved completely immune to all the primary parasites of *P. lilacinus* received in Nairobi from the Orient.

As a result of this increased knowledge and the fact that the only known distribution of *P. kenya* is within East and Central African territories, the solution of the problem of control by biological means has been re-focussed upon these territories, in some portion of which *P. kenya* may be found to be indigenous. Arrangements are being made to enable an Entomologist of this Department to carry out investigations in Uganda, Tanganyika, and the Belgian Congo on this aspect of the problem.

Experience has shown that a large number of different mealy bugs, even closely related species, can be recognized in the field by their shape, type of filaments, and the waxy pattern developed on the dorsum, whereas it may be extremely difficult to separate and identify the species by an examination of excellent slides made from the same material. These characters can be admirably portrayed and suitably magnified by adequately good photographs of living specimens, provided the wax has not been removed by attendant ants, as is often the case. Though the number of species which have been photographed is relatively small, the results indicate that once the waxy pattern of a species is

known it is easily possible to separate and identify the different species of mealy bug from each other. For example, the three species of mealy bug, *Pseudococcus lilacinus*, *P. citri*, and *P. kenya*, which in the past have been confused with each other, are easily identified from each other by an examination of adequately good photographs of living specimens. Whether such would prove to be the case for all mealy bugs is worthy of investigation.

It is realized that it is seldom possible for systematists to be so fortunate as to have living specimens of mealy bugs for examination and determination, and it is suggested as a result of the above experience that it may possibly be of great assistance if, where possible, good photographs of single specimens of living mealy bugs accompanied the dried or mounted specimens as at present forwarded for determination. Such photographs could be examined in conjunction with the morphological characters used for the separation of the species and could be kept along with type slides and specimens in a collection.

A start has already been made to gather together a collection of photographs of the mealy bugs present in Kenya for forwarding along with specimens of mealy bugs to the Imperial Institute of Entomology in the hope that these may prove to be of value.

MAIZE STALK BORER

(*Busseola fusca* Fuller)

Stalk borer of maize having increased considerably during the previous season planters requested Government to enforce the Maize Stalk Borer Rules during 1937. Thus under the Diseases of Plants Prevention (Amendment) Rules, 1936, it was ordered that all maize roots, stalks, and shelled cores in the Nakuru and Ravine districts of the Rift Valley Province should be destroyed by the 7th day of February, 1937, and that the planting of maize was prohibited before the 15th February, 1937, and between the 31st of May, 1937, and the 15th of February, 1938.

The carrying out of the above resulted in such considerable reduction in the population of maize stalk borer that little damage was caused during the year, and the effectiveness of these rules was again demonstrated.

PYRETHRUM

A species of thrips identified as *Thrips tabaci* Lind., was present on pyrethrum plants throughout the areas in which this plant was growing, and in some instances heavy infestations were experienced. Where the application of control measures became necessary, spraying with lime sulphur (Capex) 1 in 80 resulted in complete control of the pest.

During the year spotting and premature browning of the ray florets of pyrethrum flowers occurred, which resulted in these flowers being classified as Grade II, with consequent financial loss to the growers. It has been shown that the spotting and browning of the florets is caused by the fungus *Alternaria* sp. Whether there is any connexion between this fungus disease and the incidence of thrips has not yet been determined, though the disease has been reproduced under controlled conditions in the greenhouse in the absence of thrips.

COTTON

The following is a list of new records of pests on cotton in Kenya:—

(a) Attacking bolls—

Stalagmostethus furcatus (Lygaeidae)

Menida decoratula (Pentatomidae)

Piezodorus purus (Pentatomidae)

Acrosternum millierei (Pentatomidae)

Veterna natalensis (Pentatomidae)

Agonoscelis versicolor (Pentatomidae)

Larvae of *Argyroplaca leucotreta* (Eucosmidae).

(b) *Crossotus albopunctatus* (Lamiidae), cutting stems of all ages including the main stem.

Tetracyphus odontomus (Curculionidae), eating the bark on the stems.

Systates sauberlichii (Curculionidae), eating young bolls.

Monolepta sp., near *rubricosa* (Galerucidae)

Coryna sp. (Meloidae)

Pachnoda sinuata (Cetoniidae).

The following plants have been discovered supporting all stages of the species of *Dysdercus* shown, and are considered to be indigenous host plants of those species:—

Hibiscus gossypinus, *H. aponeurus*: *Dysdercus nigrofasciatus*.

Abutilon mauritianum, *Pavonia urens*: *Dysdercus nigrofasciatus*.

Sida schimperiana (Kikuyu Box): *Dysdercus nigrofasciatus*.

Hibiscus aponeurus, *Pavonia urens*: *Dysdercus cardinalis*.

Pavonia schimperiana: *Dysdercus cardinalis*.

Thespesia barckena: *Dysdercus fasciatus*.

Sida schimperiana: *Dysdercus orientalis*.

All the above host plants are common in the Central Province of Kenya, in which district they were collected. It is interesting to note that *Dysdercus fasciatus* was found on an arboreal host only, and that *Dysdercus superstitiosus* has not yet been recorded from the Central Province; also *Dysdercus orientalis* has not yet been collected from cotton in Kenya.

The chief stainers of cotton in the different provinces where the crop is grown are given below:—

Central Province—

Dysdercus nigrofasciatus

Dysdercus cardinalis

Dysdercus fasciatus

Nyanza Province—

Dysdercus superstitiosus

Dysdercus nigrofasciatus

Coast Province—

Dysdercus superstitiosus

Dysdercus nigrofasciatus.

ARMY WORM

(*Laphygma exempta* Walk.)

Hordes of caterpillars of the moth *Laphygma exempta* appeared in the Nairobi district towards the middle of March. Two generations were produced and then the caterpillars disappeared as suddenly as they had appeared.

The pest appeared in the Gilgil district at the end of April, in the Nakuru district at the beginning of May, and completely disappeared at the end of June. When it is considered that some hundreds of square miles of land were infested by these caterpillars the damage they caused was comparatively slight. In certain areas grazing was destroyed and in the Nakuru district some 1,600 acres of young maize were eaten to such an extent that replanting became necessary.

An analysis of the meteorological data available from the various districts over several periods of known outbreaks shows a distinct correlation between outbreaks and periods of high temperature and low humidity.

The only parasites obtained from the larvae were a Braconid, *Zelee* sp. and a Tachinid *Nemorea ricinus* Wlk. After the advent of the rains thousands of caterpillars could be seen hanging from grass stalks, these larvae having been destroyed by bacterial and fungus diseases. It seems probable that this pest is controlled more by these diseases than by parasites, which may account for their sudden disappearance under certain weather conditions. The pest is so spasmodic in its appearance, and the percentage deaths among the larvae in captivity so great that investigations in the laboratory become exceedingly difficult.

LOCUSTS

A relatively small swarm of red locusts (*Nomadacris septemfasciata* Serv.) suddenly appeared between Nairobi and Athi River Station on the 28th July, but there is no authoritative information as to where this swarm originated, though it is probable that it originated in Tanganyika. The swarm flew in a northerly direction and remained scattered in the Kiambu district for five or six days. No reports of any damage were received, neither is there any information available of the ultimate fate of the swarm, which has not been heard of since the beginning of August.

Two medium-sized swarms of the red locust entered Kenya from Uganda through Busia and Tororo between the 18th and 23rd September. Each of these flying swarms was estimated to have covered some 8,000 to 10,000 acres when at rest. These swarms in the main returned to Uganda on the 28th and 29th of September, leaving stragglers behind in various places, chiefly in the area between Broderick Falls and Lugari railway station in the valley of the Nzoia River.

While the swarms remained in the Colony they visited various locations throughout North Kavirondo and entered North Gem in Central Kavirondo. Offshoots of the main swarm penetrated the Uasin Gishu Plateau as far as Turbo by way of the valley of the Nzoia River and entered the Trans Nzoia by way of Kimilili.

Damage to crops was slight. Cotton and simsim were attacked in Nambare and Buholo, and some 400 acres of maize were destroyed on the Uasin Gishu Plateau.

Egg-laying commenced on the 26th September and continued up to the time the swarms returned to Uganda on the 29th September. Eggs were laid in cultivated lands and in land which had been recently turned over in the districts of North Kavirondo. Owing to the high population density within the areas concerned the organization of native labour resulted in the destruction of eggs and hoppers by mechanical means and without the application of poisoned bait.

TRIBOLIUM IN COFFEE

During the year complaints were received in Nairobi that East African coffees were arriving in London infested with *Tribolium castaneum* and *Tribolium confusum*, and it was intimated that the stores in East Africa carried an unduly large population of these insects.

In order to determine the possible sources of infestation inspections were made of stores on numerous coffee estates, of railway trucks, all coffee houses in Nairobi and Mombasa, and one ship lying in Kilindini Harbour. At the time of inspection some 33,000 bags of coffee were lying in the various warehouses in Nairobi.

Though thorough inspections were made, not one specimen of *Tribolium* was discovered in any coffee store on the estate, in the railway truck, or in the coffee warehouses in Nairobi and Mombasa, and one cannot refrain from complimenting the coffee trade generally on the cleanliness of coffee warehouses.

Tribolium was found in the export transit sheds and produce godowns in Mombasa which were used for storing produce other than coffee; thus, if coffee is stored for any length of time in these sheds and godowns there is the possibility of it becoming infected with *Tribolium*, though such has not been observed.

In this regard it is illuminating to note that more than 80 per cent of the total of Kenya coffee is despatched straight to the ship without entering either transit sheds or godowns in Mombasa.

Inspection of No. 2 Hold of a ship lying in harbour revealed that *Tribolium* was present between decks where coffee was stored.

As a result of these inspections it is concluded that infestation of coffee by *Tribolium* is secondary, and results from storage near other infected produce or from storage in an infested ship.

ADDITIONS TO THE LIST OF INJURIOUS INSECTS

Coffee—

Aphanus sp. near *atomarius* Dist. (Lygaeidae).

Aphanus sp. (Lygaeidae).

Phytocoris alluandi Popp. (Capsidae).

Lygus sp. (Capsidae).

Camptobrochis sp. (Capsidae).

Curimosphena trivalis Gerst. (Tenebrionidae).

Berginus tamarisci Woll. (Mycetophagidae).

Tanymecus brevisrostris Auriv. (Curculionidae).

Systates aeneolus Har. (Curculionidae).

Acrocassis gibbipennis Brh. (Cassididae).

Retithrips syriacus Mayet. (Thripidae).

Lepidocyrtus sp. (*Collembola*) (Entomobryidae).

Heliothis obsoleta F. (Noctuidae).

Kapok—

Titoceres jaspideus Serv. (Lamiidae).

Podocarpus gracilior—

Oemida gahahi Dist. (Cerambycidae), boring in seasoned timber.

Tephrosia vogelii—

Nysius sp. (Lygaeidae).

Phaseolus aureus—

Brachyplatys testudonigra De G. (Pentatomidae).

Roots of Sugar Cane—

Scarites molossus Kl. (Carabidae).

Porphyronota alluandi Bourg. (Cetonidae).

Sunn Hemp—

Alcides obsoletus Gerst. (Curculionidae).

Cashew Nut—

Diastocera reticulata Thoms. (Lamiidae).

Glycine javanica—

Cydnus sp. (Pentatomidae).

Sesbania—

Brithys poncratii Cyr. (Noctuidae).

Hyponomeuta mobilosa Zell. (Hyponomeutidae).

Roses—

Systates nigrinus Hust. (Curculionidae).

Systates aeneolus Har. (Curculionidae).

Apophyllia fermorata Jac. (Galerucidae).

Monolepta sp. near *rubricosa* Gerst. (Curculionidae).

Linseed—

Oerorrhinus glabricollis Mshl. (Curculionidae).

Spider Lily—

Hapalia ablactalis Wlk. (Pyralidae).

Maize—

Perigrinus maydis Ashm. (Delphacidae).

Bengal Gram—

Heliothis obsoleta F. (Noctuidae).

Custard Apple—

Dolicho-thrips sp. (Thripidae).

Bougainvillea—

Peribrotus brunneus Hust. (Tenebrionidae).

Tea Roots—

Phrynocolus crispatus Frm.

Dacus (*Chaetodacus*) *curcurbitas* Coq. (Trypetidae).

This species belongs to a group of Dacinae not known to occur in Africa, and it is the first record of the insect having been found in Kenya. The fact that it was discovered near the port of Mombasa (by Dr. van Someren), the lack of any earlier records of its presence in Africa, and the absence of any closely allied species in Africa indicates that this insect has been recently introduced into Kenya from some foreign country.

Amongst the numerous visitors to the Entomological Laboratory it is pleasing to record the names of His Excellency the Governor (Sir Robert Brooke-Popham), Earl De La Warr, Sir Frank Stockdale, Mr. D. L. Blunt, Director of Agriculture, Nyasaland; Mr. J. J. B. Deuss, formerly Director of the Java Tea Research; Mr. G. S. Cameron and Mr. J. E. Peet from Southern Rhodesia; Mr. Percy Kent-Norris, Acting Commissioner, U.S.A.; Mr. Ernest, Costa Rica; Messrs. R. Dupret, F. Casiam, G. C. Lefeire, F. Gumoer, G. de Bra-bandere, L. Ghesquiere, M. Andre Le Brun, from the Belgian Congo; Mr. H. Hargreaves, Entomologist, Uganda, and Mr. Harold Compere from California. The interchange of information and the establishment of personal contact with scientific officers from others countries are most valuable.

ACKNOWLEDGMENTS

I wish to record again my appreciation of the assistance given by the staffs of the Imperial Institute of Entomology; the staff of Imperial Airways in Nairobi for their kind co-operation and assistance on the arrival of consignments of parasites. Special acknowledgment is paid to Mr. Ghesquiere, Chief of the Division of Phytopathology and Entomology in the Congo Belge for his keen interest and valuable assistance in our mealy bug problem as a result of his visit to the Scott Agricultural Laboratories.

INVESTIGATIONAL WORK

Antestia Dusting Experiments

During the year three series of experiments were carried out to test various dusts against locally produced pyrethrum powder for the control of *Antestia*.

In each experiment three replications were made and all materials were applied by means of converted sovereign pumps using twenty strokes of each pump per tree.

The materials used and the mean percentage kill of *Antestia* obtained is set out in tabular form below:—

EXPERIMENT 1

	Pyrethrum Powder	'Killer Dudu'	Tobacco Powder
	<i>Per cent</i>	<i>Per cent</i>	<i>Per cent</i>
Kill Obtained ..	98.4	81.2	52.2

EXPERIMENT 2

	Pyrethrum Powder	Pyrethrum Tobacco	Pyrethrum Tobacco
		(Mixture 50%-50%) Per cent	(Mixture 25%-75%) Per cent
Kill Obtained ..	90.6	92.4	74.9

EXPERIMENT 3

	Pyrethrum Powder	Pyrethrum Tobacco
		(Mixture 50%-50%) Per cent
Kill Obtained ..	83.3	56.0

"Killer Dudu" is a locally produced mixture, the composition of which is known only to the producer.

The tobacco powder used above was obtained in each case from the same farm from locally grown tobacco. The samples used in Experiments 1 and 3 were the same, but the samples used in Experiment 2 were obviously dissimilar. The nicotine content of the various tobaccos used was not known to the writer. The percentage kill obtained in Experiment 2 and 3 using pyrethrum powder alone is so much below that obtained in Experiment 1 which may be considered as the normal percentage kill when using finely-ground pyrethrum powder that efforts were made to discover the cause. It was eventually discovered that the pumps used in these latter experiments were from a new consignment and were delivering from 35 per cent to 40 per cent less powder than the pumps previously used in Experiment 1.

The pumps recommended for use in Antestia control are of the converted sovereign type delivering 5 g. of pyrethrum powder per twenty strokes of the pump. Such pumps were used in Experiment 1. In Experiments 2 and 3 the four new pumps tested were found to be delivering 4.29, 4.11, 2.48 and 2.47 g. per twenty strokes respectively. Examination of these pumps revealed the fact that the tubing used for adapting them to dusting operations was thick-walled with an internal diameter of $\frac{1}{8}$ in. instead of $\frac{3}{16}$ in.

The smaller delivery of powder no doubt affected the spread and is sufficient to account for the smaller percentage kill obtained in Experiments 2 and 3.

The conclusions which can be drawn from the above experiments are:—

- (a) Pyrethrum powder applied at the rate of 5 g. per twenty strokes per tree gives a very high percentage kill of *Antestia* and confirms the results obtained in the original experiments conducted by the writer in 1935.
- (b) "Killer Dudu" is a material toxic to *Antestia* but the percentage kill of *Antestia* obtained does not justify this material being used in place of pyrethrum powder.
- (c) Tobacco powder is only slightly toxic to *Antestia* and the percentage kill obtained varies considerably.
- (a) Pyrethrum/tobacco fifty-fifty mixture.—The results obtained to date indicate that further investigations are necessary before definite conclusions in regard to the efficacy of this mixture can be arrived at.
- (e) It is necessary to standardize the converted sovereign pumps to deliver not less than 5 g. of powder per twenty strokes if reliable and satisfactory results are to be obtained when using pyrethrum powder in the control of *Antestia*.

GERMINATION TESTS OF COFFEE SEED

1. Owing to the conflicting opinions recently expressed on the effect upon germination of coffee seed of different moisture content subjected to various treatments for the control of *Stephanoderes* a series of germination tests was made.

2. These tests were carried out by placing fifty coffee seeds from each sample between damp blotting paper and germination was said to have taken place when the radicle had burst through the seed coat.

3. The moisture content of different samples of coffee seed, the number of days which elapsed before the first seed germinated, the percentage germination after a given number of days and the various treatments given are summarized in tabular form as follows:—

Moisture Content of Sample	Number of Days to First Germination	Percentage Germination after Given Number of Days and Treatment
EXPERIMENT 1		Control—No Treatment
9.6%	22	30 35 40 45 50 55 60 65 70 75 80 85 90 95 100
16.3% (B)	28	30 64 84 94 98 98 Still in progress.
35.0% (A)	28	10 16 62 68 70 74 76 76 76 78 78 82 84 84 In progress.
50.0%	24	20 36 60 68 82 86 88 90 94 94 94 96 96 96 In progress.
		12 20 36 38 46 50 54 70 74 78 80 Still in progress.
EXPERIMENT 2		Fumigated with C.S ₂ 5 lb. per 1,000 cu. ft.
16.3% (B)	28	18 32 64 68 88 88 88 92 96 98 98 100 Complete.
35.0% (A)	31	2 4 12 16 42 52 56 60 60 74 84 86 86 90 90 In progress.
EXPERIMENT 3		Fumigated with C.S ₂ 32 lb. per 1,000 cu. ft.
16.3% (B)	34	— 6 22 28 48 48 48 56 62 72 76 84 86 92 94
35.0% (A)	34	— 4 20 48 68 78 84 90 90 94 98 One seed dead (Complete).
EXPERIMENT 4		Heated in stream of saturated air at 120°F. for half-an-hour
16.3% (B)	31	10 16 44 44 66 68 70 72 72 76 76 82 82 84 94 In progress.
35.0% (A)	31	4 10 30 40 56 60 66 70 70 76 82 82 82 82 82 In progress.
EXPERIMENT 5		Heated in closed vessel at 120°F. for half-an-hour
16.3% (B)	23	12 14 48 54 82 82 84 84 88 90 90 90 90 90 Still in progress.
35.0% (A)	34	— 4 25 32 50 68 70 76 80 88 90 90 90 92 92 Still in progress.

It is well known amongst coffee growers that the rate of germination and the germinating capacity of wet coffee seed varies enormously and that such seed takes approximately three months to germinate satisfactorily; this is borne out by the results of the above series of tests.

Since it has been shown by Hargreaves in Uganda and by Notley in Kenya that *Stephanoderes* cannot live in coffee with a moisture content of 12.5 per cent or less or in coffees known to the trade as dry coffee, a germination test was made using an over-dried coffee with a moisture content of 9.6 per cent. It will be noticed from the above table that the rate of germination of this dry coffee is superior to any of the wet coffee tested and the percentage germination of 98 per cent is highly satisfactory.

A greater series of germination tests would need to be made before any slight differences in germination capacity as might have been caused by the different treatments could be shown to be statistically significant, but the results obtained indicate that the treatments given caused no difference great enough to be considered of practical importance.

The germinating capacity of dry coffee seed has such an important bearing upon the problem of control of *Stephanoderes* in imported coffee seed that a large series of germinating tests using dry seed are to be undertaken.

MAIZE STORAGE

Experiments have been conducted in the laboratory to determine whether the weevil *Calandra (Sitophilus) oryzae*, L., can be killed and so prevented from breeding in maize stored in air-tight containers since considerable doubt has been expressed in the efficacy of this method.

For this purpose six 4 oz. bottles with screw caps fitted with cork insets were filled with dry maize (moisture content 12½ per cent) and six live weevils introduced into each bottle.

Experiment A.—Two bottles were taken, the caps screwed tight and sealed with paraffin wax.

Experiment B.—Two bottles taken and the caps screwed tight but not sealed.

Experiment C.—Two bottles without caps were left open to the dry atmosphere of the laboratory.

After a period of ten months the bottles were opened and the contents examined with the following results:—

- A.—Six dead weevils were found in each bottle; no larvae or pupae were discovered and the maize was in perfect condition. No mould was present.
- B.—In each of these two bottles the maize was green with mould and completely riddled by weevil. From one bottle examined 165 living and dead weevil were obtained together with 63 living larvae and pupae. The maize felt wet on handling.
- C.—In each of these two bottles only the lower layers of maize had been attacked by weevil—in one bottle examined seventeen living and dead weevil and two living larvae were obtained. Also a severe infestation of mites was present. No mould had developed. The moisture-content of this maize was $12\frac{1}{2}$ per cent.

Owing to the severe weevil infestation in bottles B which were thought to be air-tight, the bottles were placed in hot water to determine if such were the case. Gas bubbling from the caps through the water showed that the bottles were leaky. From the fact that this maize was wet whereas the maize in C in contact with the atmosphere was still dry it may be deduced that the moisture in the first instance had accumulated as a result of transpiration of the weevils present which would be increased later as a result of transpiration of the moulds as these developed.

The accumulation of moisture would also play an important part in the increased development of weevil since it is well known that weevils develop more rapidly in wet than in dry maize.

The results of these experiments show that:—

1. Weevils cannot breed and are killed in maize stored in and filling an air-tight container.
2. Weevils continue to breed in maize stored under conditions apparently air-tight but which are in fact leaky and such conditions are more favourable to the development of weevils and moulds than the conditions which obtain when dry maize is stored exposed to a dry atmosphere.

The problem of protecting grain stored in bulk from insect attack is of world-wide importance and appears to warrant experiments in air-tight storage being conducted on a large scale. The construction of air-tight granaries or silos is a problem for the engineer but there seems to be no insuperable difficulties in the way. If such experiments were successful air-tight granaries could be constructed in large grain-growing areas and at terminal points wherein grain could be stored for suitable periods before shipment entirely free from insect life. It then would be possible to equalize shipments and avoid the rush to get grain away after harvest. Such methods of storage may possibly provide the best means of maintaining reserves of grain to meet emergencies such as war or failure of crops.

GERMINATION TESTS

Fifty seeds were taken from one bottle which had been sealed with wax for ten months (A. above).

Fifty seeds were taken from one open bottle (C. above).

The seeds were placed between wet blotting paper and the results of germination are given below:—

DAYS	PERCENTAGE GERMINATION AFTER A GIVEN NUMBER OF DAYS							
	3	4	6	7	8	9	10	11
SEEDS FROM BOTTLE A	32%	60%	88%	88%	90%	92%	92%	92%
SEED FROM BOTTLE C	64%	88%	96%	98%	one	seed	dead	

It will be noticed that the rate of germination of the seed which had been kept in an air-tight bottle for ten months was slower and the percentage germination not so good as in the case of seed kept in a bottle open to the atmosphere for the same period.

H. WILKINSON,
Entomologist in Charge

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